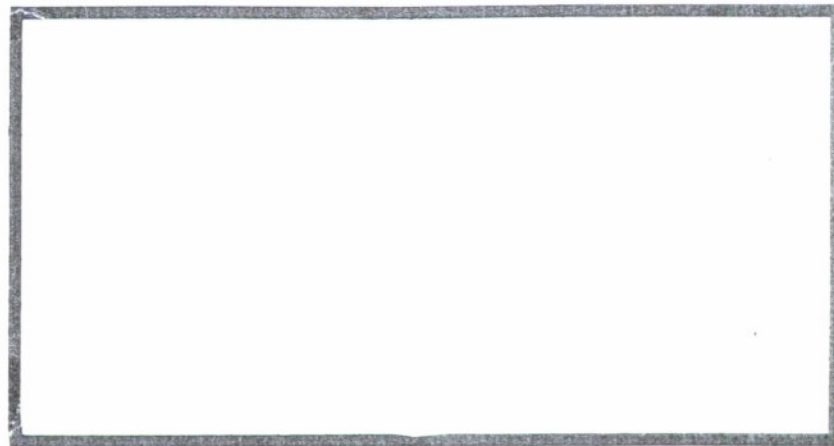


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UNITED STATES AIR FORCE  
AIR UNIVERSITY  
AIR FORCE INSTITUTE OF TECHNOLOGY  
Wright-Patterson Air Force Base, Ohio

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A STUDY TO DETERMINE THE ADEQUACY OF  
THE TOOLS AND EQUIPMENT USED BY  
AIR FORCE WOMEN IN THE CRAFT SKILLS

Philip J. Bolalek, Captain, USAF  
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The tools and equipment now used in maintenance, electronics, and civil engineering, were designed to meet the needs of a totally male work force. This study addresses the adequacy of the tools and equipment for the women who are now working in these specialties. The method of approaching this potential problem was to obtain the opinions of the women working in these specialties through self-administered questionnaires. If more than ten percent of the respondents in a specialty considered a tool or equipment item to be inadequate, that item was considered inadequate for women in that specialty. Twenty-four items were identified as inadequate; six of these items were inadequate in more than one specialty. This study also collected data on the age, height, weight, and hand length of the women working in these specialties. In addition to the identification of inadequate tools and equipment for women, this study found that some of these items may also be inadequate for men. Additionally, potential problems were discovered with the quality of tools used in these specialties and with the suitability of women for these specialties. Further study was recommended in all of these areas.



SLSR-14-75A

A STUDY TO DETERMINE THE ADEQUACY OF THE  
TOOLS AND EQUIPMENT USED BY AIR FORCE  
WOMEN IN THE CRAFT SKILLS

A Thesis

Presented to the Faculty of the School of Systems and Logistics  
of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the Requirements for the  
Degree of Master of Science in Logistics Management

By

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January 1975

Approved for public release;  
distribution unlimited

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has been accepted by the undersigned on behalf of the  
faculty of the School of Systems and Logistics in partial  
fulfillment of the requirements for the degree of

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## CHAPTER 1

### INTRODUCTION

#### Statement of the Problem

The United States Air Force considers its people to be its most valuable resource. Consequently, a major consideration in Air Force policy decisions is the development of the full potential of each individual. Over the next five years, a growing number of these individuals will be women. Their role in the Air Force will not be restricted to positions previously stereotyped as women's jobs (i.e., medical and administrative); it will cut across the full spectrum of non-combat specialties within the Air Force (14:27-31).

The tools and equipment now used in the non-combat specialties, e.g., maintenance, electronics, and civil engineering, were designed to meet the needs of a totally male work force. These tools may or may not be appropriate for females. Adequate tools are required to develop the full potential of the women who are entering these previously all-male specialties. Therefore, there is a need to determine whether or not the tools and equipment now being used are adequate to meet the needs of women.

#### Background

On November 17, 1972, the Chief of Staff approved a

plan to increase the number of women in the Air Force. This approval was followed by a message, AF/DP 1825, 21 November 1972, which advised that annual procurement of WAF would increase gradually until it tripled the 1972 force level by June 30, 1978 (15:8). This would make the enlisted WAF strength more than 40,000. Table 1 shows the projected WAF strength for fiscal years 1974 to 1978.

Table 1  
Projected Enlisted WAF Procurement and Strength<sup>1</sup>

Fiscal Year	Enlistments	End of Year Strength
1974	8,000	18,776
1975	10,000	23,617
1976	12,000	27,229
1977	14,000	35,298
1978	16,000	41,554

Twelve previously all-male career areas were opened to women on January 1, 1973. These specialties have been operationally defined in this study as craft skills and include the communications-electronics, missile-electronic maintenance and avionics systems specialties; the aircraft, aircraft accessory, vehicle, missile, munitions and weapons maintenance specialties; the metalworking specialty; and the

<sup>1</sup>Data provided by the Air Force Military Personnel Center, Randolph AFB, Texas (22).

mechanical/electrical, structural/pavement, and sanitation specialties of civil engineering (17:14). The number of women working in the craft skills is increasing; therefore, the need for an investigation of the adequacy of the tools and equipment used in the craft skills is also increasing. One method of conducting such an investigation is from a human engineering perspective.

Human engineering is a segment of modern technology that relates human capacities and limitations to the design of machines, tools, and work environments (3:vii). The modern impetus into human engineering began during World War II, although earlier experiments can be traced back to Leonardo da Vinci (20:49). The rapid technological advancement of complex systems such as radars, rockets, submarines, and electronic computers requires more than mere guesswork on the part of machine designers (3:vii). Machine designers must consider the human factor in determining design constraints because:

Although man is an extremely versatile functional component, his use in a system imposes problems and constraints on the designer. These problems and constraints result from the physical and behavioral variations among men, the structural and functional limitations of the body, the requirements for man's safety and comfort, and the need to maintain his physiological functions [25:34].

Structural differences among people (i.e., arm length, height, hand width, etc.) are important in equipment design. There are correlations among the body height, weight, and strength that must be considered when tools and equipment



are being designed. Man's limits, expressed as applied force, speed, and type of movement in pushing, pulling, or turning objects, are also important considerations in designing tools (25:34-37). The study of measuring various human physical traits is known as anthropometry. This study centers around the measurement of physical traits such as size, mobility, and strength. Engineering anthropometry applies anthropometric data to equipment, work areas, and clothing design to enhance the efficiency, safety, and comfort of the worker (25:467). Thus, engineering anthropometry is important in tool design. The development of a tool that fits the job and the user is the primary objective of a tool designer. Van Cott and Kincade believe that the proper procedure for designing tools and equipment to accommodate human dimensions consists of five steps:

1. Determine the body dimensions that are important in the design of the item.
2. Establish the range of body dimensions for the prospective users of the item.
3. Select the relevant percentage of prospective users that the tool should fit.
4. Select values from the appropriate dimension table that correspond to this percentage.
5. Determine the type of clothing worn while using the item and add the relevant clothing increment (25:478).

The great variability of human physical traits suggests that to the tool designer the range of each dimension is as important, or even more important, than the average physical dimension. Additionally, the time that

the dimension measurement occurred is important because the dimensions and their variability change over time.

Significant differences in height and weight at the same age have been recorded between fathers and their sons. A general trend of increasing weight and height seems to be continuing in the United States. Military anthropometric studies have substantiated this trend in men (25:468-469). The recognition of this trend caused the Department of Defense to initiate a new military anthropometric study to update the studies conducted after World War II. This new study was conducted between 1965 and 1967 on 19,000 men in the armed services (25:470).

Prior to 1968, anthropometric data on Air Force women was not readily available. Consequently, General (then Colonel) Jeanne M. Holm requested that an anthropometric study of Women in the Air Force (WAF) be conducted to provide data for use in designing equipment and arranging functional work areas for WAF (4:iii; 5; 16). This study was conducted on 1905 women, and the final results were published in April, 1972. However, at the time of this study, WAF were primarily concentrated in the medical and administrative career areas. There were no WAF in the craft skills. Since the opening of the craft skills to WAF in January, 1973, no studies have been conducted to determine whether or not dimensional differences exist between the women in the craft skills and the women in the medical and administrative specialties (5; 16). The tools and equipment

now used by the WAF working in the craft skills were designed for men and they may not meet the needs of women.

### Objective

The objective of this thesis is to determine if the tools and equipment now used in the craft skills by WAF are adequately meeting their needs.

### Scope

This thesis should be the first part of a six-part study to determine and correct any inadequacies in the tools and equipment used by WAF in the craft skills. The complete study would be composed of the following parts:

1. The identification of standard tools and equipment that may be inadequate for WAF.<sup>2</sup>
2. The validation of the inadequacies experienced by WAF using the standard tools and equipment.
3. The investigation of possible modifications to tools and equipment presently in use.
4. The development of anthropometric data on WAF in the craft skills.
5. The redesign of the inadequate standard tools to accommodate female users.
6. The evaluation of the redesigned tools to insure that the inadequacies have been corrected.

---

<sup>2</sup>Standard refers to tools and equipment designed to meet the physical dimensions of male users.

This thesis will be limited to the identification of tools and equipment used by WAF which are, or seem to be, inadequate for their use. Since it is only the first part of a continuing study, the research question approach is considered most appropriate.

### Research Question

Given that the tools and equipment now used in the craft skills were designed for men and that the number of women working in these skills is expected to increase, are any of the tools or equipment now used in these skills considered inadequate by WAF?

### Preview of the Remainder of the Thesis

This chapter has addressed the problem, objective, scope and research question of the thesis, and some background material has been provided to clarify the approach that will be used in the remainder of the thesis. The second chapter contains historical information on women in civilian occupations similar to the military craft skills and the history of women in the military; this chapter may be skipped by the hurried reader without loss of continuity. The details of the methodology used in addressing the research question is presented in the third chapter. The fourth chapter provides an analysis of the data obtained in the study. The summary, findings and conclusions are presented in the fifth chapter.



## CHAPTER 2

### WOMEN IN THE CRAFT SKILLS

#### Introduction

The entry of women into the previously all-male skills within the Air Force is only one example of the changes that are taking place in the role of women in the Air Force and in society. During the past seventy-five years, women have exerted increasing influence in our society by attacking their traditional roles which were established for them by men. The traditional role of women in the national work force is one of the areas which has experienced great changes as a result of this increasing female influence.

#### Women in the Work Force

Today, women constitute 38 percent of the national work force. Most of these women are still employed in sex-stereotyped occupations, such as domestic servants, typists, sales clerks, and nurses (19:470). A steadily increasing percentage of women, however, are attacking this practice of sex-stereotyping and are entering previously all-male occupations.<sup>1</sup> In 1960, 277,000 women were employed in the

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<sup>1</sup>For example, in 1940 only 2½ percent of all bartenders were women; today women constitute 30 percent of the nation's bartenders (26:9).



male-dominated skilled trades; by 1970, this figure had risen to almost 500,000.<sup>2</sup> The overall percentage of women in these skilled trades increased from 3.1 percent in 1960 to 5.0 percent in 1970. The increase in the number of women in the skilled trades has occurred while the number of men in many of these trades has decreased or remained stable (12:14). These trade skill occupations closely parallel the specialties in the career fields that have been defined in this study as the craft skills. Table 2 shows some of the work force changes that have occurred in some typical skilled trades between 1960 and 1970.

#### Possible Causes of Recent Changes

What has caused the rapid increase in the number of women in the skilled trades? A significant factor was the rebirth of the feminist movement in the mid-sixties and its effect on the social, legal, economic, and psychological fabric of the nation. Women began reviewing their social status and they began demanding a more rational division of work in both the home and the work place. They began attempting "masculine" skills, such as carpentry and plumbing, on a do-it-yourself basis to help reduce the cost of maintaining their homes. Adult education classes in these skills sometimes evolved into occupational training

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<sup>2</sup>The skilled trades as defined by the Bureau of the Census include such occupations as: construction worker, bulldozer operator, carpenter, electrician, aircraft mechanic, machinist, automobile mechanic, plumber, and sheet metal worker (12:16).

Table 2  
Women Employed in Some Skilled Trades<sup>3</sup>

Trade	Number of Women Employed		Percent of Total Work Force	
	<u>1960</u>	<u>1970</u>	<u>1960</u>	<u>1970</u>
Construction Worker	206	1,608	.2	1.1
Stonemason	722	2,049	.5	1.3
Carpenter	3,312	11,059	.4	1.3
Electrician	2,483	8,646	.1	1.8
Machinist	6,685	11,787	1.3	3.1
Aircraft Mechanic	1,665	4,013	1.5	2.9
Automotive Mechanic	2,270	11,130	.4	1.4
Painter	6,449	13,386	1.9	4.1
Plumber	952	4,110	.3	1.1
Sheetmetal Worker	1,530	2,902	1.1	1.9
Telephone Repair	3,018	8,289	2.0	3.5
Telephone Line Repair	824	762	2.0	1.5

<sup>3</sup>Data extracted from 1970 Census of Population, Detailed Characteristics, U.S. Summary Final Report PC(1)-D1 (Bureau of the Census), Table 221.

for many women. With their legal right to equal employment opportunity established by Title VII of the Civil Rights Act of 1964, women began to seek economically appealing jobs previously restricted to men by prejudice or tradition. The skilled trades were among these economically appealing jobs (12:17-18).

In addition to the economic advantages offered by the skilled trades, the work environment of many of these trades offered more independence and freedom of movement than the environment of the typical clerical position. Some women found the manual labor and the freer environment more satisfying. Perhaps the prime psychological factor which brought women into the skilled trades was employer confidence in their potential performance (12:17-18).

Such confidence has been building for several decades. The employment of women in skilled jobs in aircraft plants, shipyards, foundries, and other defense industries during World War II had a strong and lasting effect on attitudes. The women who worked in those jobs captured the imagination of the public. More important, their work was compared favorably with that of men with equivalent training and experience 12:18.

Employer confidence was not just a product of past performance; it was supplemented by information from the U.S. Employment Service (USES). The USES considers seven areas which are tested in the General Aptitude Test Battery to be important to success in the skilled trades. In these seven areas, women generally excel in four, men in one, and two reveal no difference between sexes (12:19). Table 3 lists these seven areas and indicates which sex has the

higher average performance.

Table 3  
Aptitudes for Skilled Trades

Aptitude	Higher Average Performance
Numerical Reasoning	No Difference
Spatial Reasoning	Male
Form Perception	Female
Clerical Perception	Female
Motor Coordination	Female
Finger Dexterity	Female
Manual Dexterity	No Difference

#### The Expanding Potential of Women in Skilled Trades

Women now have the desire, ability, and opportunity to expand their potential in the national work force. The possibilities for expansion are not limited to civilian industry, but include civil service and military occupations as well. In the November, 1974 edition of Reader's Digest, an article condensed from the Saturday Evening Post by Katherine Robinson entitled, "Promising Career Areas for Women," listed the armed forces as one of the nine most promising careers for women in the 1970's. These careers were chosen after numerous interviews with women, their employers, and the United States Department of Labor. This



article states:

In recent years the services have opened up almost every job to women--from air maintenance to advanced communication and flying; only combat related jobs are restricted. Air Force General William V. McBride, for example, recently announced a 150 percent increase in the number of WAF's in the Air Force by 1978. Women aviators, chaplains, surgeons, security officers, all find a welcome today [18:135].

What has caused the military to become one of the most promising career fields for women? One answer is provided by Ms. Kate A. Arbogast, a research economist with the George Washington University Naval Manpower Research Project.

Why is it that now is the time that the services are enlisting more women? Two unconnected events have occurred recently to bring about the emphasis on woman-power. The first event is the shortfalls of manpower being experienced by the various services. This has arisen partly because of unfavorable public opinion toward the military occupational choice and partly because of the change to a draft-free environment. The second event is the action which is being taken on the 27th, or Equal Rights, Amendment to the Constitution. The passage of this amendment would mean, among other things, that job discrimination on grounds of sex would cease to exist [2:9-10].

In her concluding paragraph, she also states:

The Military Establishment today faces a problem of filling its manpower needs with the most qualified personnel at the least cost. The information now available hints that women may be more cost-effective than men, even given a higher turnover rate for women. Such a finding was reported in an unpublished submission of the Air Force Directorate of Personnel Plans to the Central All-Volunteer Task Force, Office of the Assistant Secretary of Defense (Manpower and Reserve Affairs). But, even if the scales balanced perfectly in terms of dollars and cents, women could prove to be the answer to the military's qualitative and quantitative personnel problems for two reasons:

1. They enter the service on a higher qualitative base than do men and are, therefore, likely to be more productive.



2. In past years, the excess supply of volunteers has demonstrated that there is a supply of women wanting to serve in the Armed Forces.

Realists might add a third reason: There does not seem to be an alternative [2:19].

### Women in the Military

The role of women in the military has not been immune to the changing attitudes that have occurred over the past seventy-five years. Women have served with the military since 1898. It is only in recent years, however, that women have become fully integrated into all aspects of military service. Before discussing this integration within the Air Force, it is important to briefly trace the history of women in the armed services from 1897 to 1947 when the Air Force became a separate service.

Women first served with the Army as contract nurses during the Spanish-American War. Their invaluable and distinguished service during that war prompted Congress to create the Army Nurse Corps in 1901 and the Navy Nurse Corps in 1908. These women, however, did not receive military rank, officer status, or the equivalent pay and benefits that were given to men until 1924 (1:15).

During World War I many allied nations formed women's service units; the United States, however, did not. This did not mean that women did not serve their country during World War I. Over 11,000 women volunteers enlisted

as Navy Yeomanettes and Marine Corps Marinettes.<sup>4</sup> In addition, 233 women served as bilingual (French-English) telephone operators for the American Expeditionary Forces in France (1:15). Women's accomplishments during World War I were exemplified by Miss Julia Stimson, an Army nurse, who received the Distinguished Service Medal from General of the Armies John J. Pershing in recognition of her exemplary nursing services (2:11).<sup>5</sup>

The intervening years between World War I and World War II saw the virtual elimination of women in the military. Under the laws enacted during that time, no service could enlist women. Only the Army and Navy Nurse Corps remained.

The United States' entry into World War II on December 7, 1941, again required women to augment the military forces of the United States. This time, however, Congress passed a bill, in May, 1942, establishing the Women's Army Auxiliary Corps (WAAC). This bill gave full military status to women for the duration of the war plus six months. In 1943, the WAAC was made a true component of the Army and the name of the women's corps was shortened to Women's Army Corps (WAC) (2:14). By the end of the war

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<sup>4</sup>Women were enlisted in the Navy and Marine Corps at enlisted ratings while they could not enlist in the Army because of a legal loophole. The law governing Naval enlistment specified only "citizens" whereas the law for Army enlistment specified "male persons." This loophole was closed by the Naval Reserve Act of 1925 which inserted the word "male" in front of citizen (2:12-14).

<sup>5</sup>Miss Stimson later became the superintendent of the Army Nurse Corps from 1919 to 1937 (2:11).

women's components were integrated into every branch of the military.<sup>6</sup>

By 1945, over 265,000 women were serving in the armed forces. Almost 40,000 of these women served in the Army Air Force (AAF). The AAF was the first major command within the Army to admit enlisted women into all of its non-combat schools and to integrate women into its rank structure (1:15).

#### Women in the Air Force

In 1947, the Air Force became a separate service, and with this separation, the component Women in the Air Force was established. From 1947 to 1967, the number of enlisted WAF remained at or near 5,000 women with the brief exception being the increase that occurred during the Korean War. From 1967 to 1972, the number of enlisted WAF gradually grew to 11,000 women, but these women were still chiefly used in only the administrative and medical skills. Before the end of 1972, however, a major change in this traditional role took place (2:9-19; 14:31-32; 24:13).

The Department of Defense's Human Goals Program and the initiation of the All-Volunteer Force focused special attention on the role of women in the armed forces. This attention was centered on maximizing the benefit to both

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<sup>6</sup>It is interesting to note that the original name given to women in the Navy, WAVES (Women Accepted for Volunteer Emergency Service), is still used even after the emergency of World War II.



the armed services and the individual women while insuring their equal opportunity and treatment in all aspects of military life (24:13). In June, 1972, Brigadier General Jeanne M. Holm, Director of Women in the Air Force, in discussing the WAF role stated:

They are full-fledged members of the U.S. Air Force with the responsibilities, advantages, and challenges that go with that membership. They will be used across the full spectrum of non-rated fields that are within their capabilities, all over the world [14:31].

To achieve this full-fledged membership, previous assignment and career specialty policies had to be changed. As late as 1973, there were 33 major Air Force bases within the United States to which lower grade WAF airmen in any specialty could not be assigned (21:1).<sup>7</sup> In order to open these and other bases to enlisted WAF, the Air Force developed the WAF Dispersal Plan. The goal of this plan was to eventually achieve complete interchangeability of assignments for men and women with the same skill by making all 136 major Air Force bases open to WAF (21:1). If this plan was to achieve complete interchangeability, the restrictions placed on women entering traditionally male career fields also had to be changed. On January 1, 1973, 141 new career specialties were opened to women. This left only five enlisted specialties closed to women: Defensive Fire Control, Inflight Refueling, Flight Engineer, Aircraft

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<sup>7</sup>Lower grades are defined as the ranks airman basic (E-1) to sergeant (E-4).

Loadmaster, and Pararescue Recovery (17:14). Section 8549, Title 10 of the U.S. Code restricts women from these five specialties because they could involve combats.

### The Future

Since the number of WAF is progressively increasing, a question which arises is: "What are the goals of these WAF?" Their true goals were probably stated best by General Holm in her remarks to the Fourth Annual Regional Conference, Federal Women's Program on April 23, 1974, when she stated:

Ultimate success will be characterized by the diminishing need for the affirmative action program and the eventual abolishment of the office charged with it. The millennium will have arrived when there is no longer a need for equal opportunity offices, women's coordinators, and directors, WAF 13:12.

As the Air Force approaches its goal of complete equality and interchangeability of men and women in all non-combat career specialties, the needs of women in these specialties must be considered. One of the basic needs that must be considered is whether the tools and equipment used in previously restricted career specialties, such as the craft skills, meet the needs of WAF. To investigate this question, a survey was made of the women in the craft skills. Details on the methodology used in conducting this survey are contained in Chapter 3.



## CHAPTER 3

### METHODOLOGY

#### Overview

A self-administered questionnaire was the instrument used to gather the data needed to address the research question:

Given that the tools and equipment now used in the craft skills were designed for men and that the number of women working in these skills is expected to increase, are any of the tools or equipment now used in these skills considered inadequate by WAF?

The questionnaires were sent to a target population of WAF working in the craft skills as of September 22, 1974. A listing of the WAF in the craft skills was obtained from the Air Force Military Personnel Center (AFMPC) through the ATLAS personnel inquiry system. The questionnaires sent to these WAF contained three sections. In the first section, the WAF were asked to provide anthropometric data so that physical dimension ranges could be established for the target population. The second section presented the WAF with a tool list for their skill and asked them to evaluate the adequacy of each of the tools they use. In the third section of the questionnaires, the WAF were asked to explain their reasons for identifying a particular tool as inadequate.

The data obtained from the first section of the questionnaires was compiled into an overall distribution

for the target population of WAF in the craft skills. This analysis was performed to serve as a comparison for the anthropometric data obtained from the study on WAF in the medical and administrative skills in 1968. The tool evaluations in the second section of the questionnaire were categorized by tool type and craft skill. Tools considered inadequate by more than ten percent of the respondents in a particular craft skill were considered inadequate. The ten percent level was chosen because it is the rule most commonly used by human engineers in evaluating the range of tool and equipment adequacy for a given target population. The tools which had been identified as being inadequate were then recommended for further evaluation.

#### Description of the Universe

The target population for this study was part of the universe which consisted of all enlisted WAF in the craft skill career fields as of September 22, 1974. The craft skill career fields are listed in Table 4. Since these career fields were opened to WAF in January, 1973, the number of women in these skills has grown to 3,838. WAF now comprise 1.77 percent of all enlisted personnel in the craft skills. Table 5 contains a listing of the total number of airmen in each craft skill, the number of WAF within that skill, and the percentage of personnel in that skill that are WAF. The Munitions/Weapons Maintenance (46) and Sanitation (56) career fields are not listed in Table 5 because there were no WAF in these career fields as of



# human factors society bulletin

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## Women Workers Rate "Male" Tools Inadequate

by Richard E. Ducharme

The number of females entering career areas previously stereotyped as "male only" is increasing in both the public and private sectors. Few would argue that females lack the intellectual capability or moral right to enter and succeed. However, it is rather well established that there are physical differences. These differences could mean that existing tools and equipment are inadequate for female craft workers and could hamper their achievement success.

Female roles in the U.S. Air Force are no longer restricted to positions stereotyped as women's jobs (medical and administrative); rather, they cut across the full spectrum of noncombat specialties. The tools and equipment used in these specialties—such as maintenance, electronics, and civil engineering—were designed to meet the needs of a totally male work force. To see if these tools are appropriate for Air Force women, a one-year study was conducted at the Air Force Institute of Technology. This article synthesizes the results of the study, originally published in the *Industrial Engineering Journal*.

### Methodology

A three-part, self-administered questionnaire was sent to 1400 Air Force women working in the craft skills. The first section asked them to provide anthropometric data so that physical dimension ranges could be established for the target population. The second section presented a tool list for each skill area and asked respondents to evaluate the adequacy of each of the tools they use as "superior," "adequate," or "inadequate." The third section asked them to explain their reasons for identifying a particular tool as inadequate.

The data obtained from the first section of the questionnaires was compiled into an overall distribution for the target population of Air Force women in the craft skills. The tool evaluations in the second section of the questionnaire were categorized by tool type and craft skill. Tools considered inadequate by more than 10 percent of the respondents in a particular craft skill were considered inadequate.

### Analysis

**Anthropometric Data.** A general profile of the females in the craft skills indicated that the average age was 21.5 years, average height was 165 cm, and

average weight was 57.5 kg. The average hand length of these women was 17.6 cm. For comparison, the average man in the Air Force is 175 cm tall, weighs 74.4 kg, and has a hand that is 19.7 cm long.

**Inadequate Tools.** Each craft skill had at least one tool or equipment item that was considered inadequate by 10 percent or more of the respondents. These items are listed in the accompanying table along with the percentage of respondents who considered the tool inadequate and a sample of the reasons given for its inadequacy. The items followed by an asterisk indicate items that were identified as inadequate in more than one craft skill; they were termed "common inadequate tools and equipment."

**Common Inadequate Tools.** The three common inadequate tools—the crimping tool, wire stripper, and soldering iron—had very similar reasons offered for their inadequacy. Some of the respondents stated that they needed two hands to squeeze the tool; thus, they needed a third hand to hold the wire. Others stated that the grips were too wide for a woman's hand. An analysis of the hand length of the respondents who identified the crimping tool and wire stripper as inadequate showed that they had an average hand length of 17.3 cm. When this hand length is compared to the hand length of Air Force men (19.7 cm), the reason women had problems with these tools is obvious; these tools were designed for men. What is more significant is that less than one percent of Air Force men have a hand that is as short as the average woman's hand.

Grip strength, one of the most important variables used in the design of hand tools, cannot be obtained from a self-administered questionnaire. However, age, height, weight, and hand size provided data from which grip strength could be estimated. The general profile of the women who were using hand tools in the craft skills showed that they were shorter, weighed less, and had smaller hands than the men for whom these tools were designed. These differences suggest that the grip strength of these women may also be less than the grip strength of their male counterparts. Thus, one could infer that the women who use these tools would have more problems than the men who use them.

### Conclusions

Most human engineers, given time to ponder the



question would conclude that physical differences between men and women could mean that tools and equipment designed for one group may not be appropriate for the other. The items identified as inadequate for females in this study are those which may have been identified *a priori*. The conclusion to be made or potential problem is that some organizations in an effort to right past wrongs may hastily integrate women into their work force without preplanning. This haste could result in an opposite and detrimental effect than what was desired.

Engineers were criticized in the early 1900's for hiring only men possessing the physical capabilities to operate existing machinery, rather than redesigning the machinery for the average man. Much research has been performed and many changes made since that time to humanize the work place.

It should be human engineers' major concern today, then, to insure that measures are taken to provide women with a total work environment which will allow them to obtain their full potential within the work force.

Note: Since first publication of these results, the U.S. Air Force has adopted a physical profile factor which assures *all* craft workers are physically able to succeed. Tool changes are also planned.

Richard E. Ducharme is an associate professor of management at Merrimack College in North Andover, Massachusetts.

### **Inadequate Tools and Equipment** (with percentage of women rating them inadequate, and some of the reasons given)

#### **Communications—Electronic Systems Field**

Work shoes\* 29%

*Too big. Too heavy. Not shaped for women.*

Soldering iron\* 17%

*Too heavy. Handle too large.*

Soldering gun 15%

*Too heavy. Can't reach trigger. Hard to hold in hand.*

Crimping tool\* 14%

*Handles too far apart. Too hard to squeeze.*

Wire stripper\* 12%

*Hard to hold in hand. Handles too far apart to squeeze.*

#### **Missile—Electronic Maintenance Field**

Twist wire pliers 29%

*Too large to grip. Handles too far apart.*

*Too long.*

Wire stripper\* 18%

*Too large to grip properly. Too heavy. Clumsy.*

Crowfoot 12%

*Awkward.*

Flexible mechanical finger 12%

*Hard to manipulate.*

Air pack 12%

*Too heavy.*

Work uniform\* 12%

*Poor fit. Impractical.*

Clamp shell 12%

*Too heavy.*

#### **Avionics Systems Field**

Work shoes\* 20%

*Too big. Too heavy. Not shaped for women.*

Wire stripper\* 19%

*Hard to manipulate. Too hard to squeeze.*

Soldering iron\* 15%

*Clumsy. Too bulky. Hard to handle.*

Work uniform\* 15%

*Ill-fitting and uncomfortable.*

Crimping tool\* 14%

*Hard to manipulate. Grip too wide.*

#### **Aircraft Accessory Maintenance Field**

Crimping tool\* 25%

*Not physically able to manipulate.*

Wire stripper\* 15%

*Too big for my hand. Handle too wide.*

Work shoes\* 13%

*Too wide at ankles.*

#### **Aircraft Maintenance Field**

Ear protectors 12%

*Too big. Hurt my head. Won't stay on.*

Goggles\* 11%

*Won't fit with glasses.*

Work shoes\* 11%

*Dig into arch and ankle.*

#### **Missile Maintenance Field**

Breaking bar

*Too heavy.*

Speed handle

*Too slippery.*

#### **Vehicle Maintenance Field**

Goggles 100%

*Don't fit.*

#### **Metalworking Field**

Metal shears 22%

*Too large. Need two hands to cut.*

Goggles\* 17%

*Fog and distortion.*

Rivet cutter 17%

*Too hard to squeeze. Awkward.*

#### **Mechanical/Electrical Field**

Wire stripper\* 18%

*Hard to grip. Fingers get pinched. Hard to cut.*

Goggles\* 14%

*Hair gets caught.*

Portable tool box 14%

*Too big. Clumsy and heavy.*

#### **Structural/Pavements Field**

Carpenter's tool chest 16%

*Too heavy.*

Jack plane 16%

*Too big.*

Caulking gun 11%

*Hard trigger. Awkward.*

Eight-ounce [230-gram] hammer 11%

*Too heavy.*

\*Common inadequate tools and equipment.



# Congress vs. Human Factors: They're At It Again

## Panel Cuts Nearly \$40 Million from HF-Related Programs

Harold E. Price, head of the HFS committee on human factors legislation reports that congressional budget trimmers are once again (see November 1975 and May 1976 BULLETINs) redlining requested funds for human factors programs in the budget of the Department of Defense. Nearly \$40 million—over half of the requested funds—has been slashed

from 10 budget items for the U.S. Army, Navy, and Air Force. Details are shown in the following "statement of concern" drawn up by the HFS committee and recommended to HFS members who wish to protest these cuts to their Senators and Representatives.

## Statement of Concern Over Reductions in Training and Personnel Technology Elements of the RDT&E Part of the FY 1978 DOD Budget

Dear \_\_\_\_\_:

I am a member of the Human Factors Society, a national organization of multidisciplinary professionals concerned with man's relation to machines and his environment. Recently the House Armed

Services Committee substantially reduced (or eliminated) funds requested for certain program elements in the Training and Personnel Technology (TPT) area as follows (figures are \$1000s):

Program Element	FY 1978 Request	Change	Recommendation
<b>ARMY</b>			
Human Factors in Military Systems	5 505	-1 505	4 000
Army Personnel & Manpower Technology	4 077	-1 577	2 500
Army Training Technology	4 967	-967	4 000
Training & Utilization in Military Systems	8 420	-2 420	6 000
<b>NAVY</b>			
Training & Human Engineering Technology	9 032	-7 032	2 000
Human Factors Engineering Development	3 478	-3 478	-0-
Manpower Effectiveness	4 872	-2 872	2 000
<b>AIR FORCE</b>			
Training & Simulation Technology	8 600	-1 670	6 930
Advanced Simulator Technology	4 900	-4 900	-0-
Flight Simulator Development	21 700	-13 200	8 500

The funding allocated to these elements is about one-half of the total funding for TPT which I understand is \$140.5 million (about one-tenth of 1% of the DOD budget); yet I believe the work supported by these funds has an impact on the reliability and support costs of all weapon systems—old and new. To be concise, I think the simple fact that these funds are used to improve the selection, training, technical materials, equipment interfaces, and overall effectiveness of the men and women in our armed services makes them (the funds) directly related to the effectiveness of the weapon and support systems. After all who ever heard of (or wants) an airplane flying, a ship on station, a tank firing, etc. without a "man" in the loop, either locally or remotely.

The cuts, \$39.7 million, made by the House Armed Services Committee are more than 50% of those program elements and 28% of the total Training and Personnel Technology area. As I indicated above, I believe these elements have a direct bearing on the technology base which underlies our military posture. I therefore urge that you consider the importance of the *human factor* in our military systems and work to have these funds restored.

(Signature) \_\_\_\_\_

(Address) \_\_\_\_\_



*I don't mind losing funds in the budget, but at least they could spell "anthropometric" correctly.*

## Is Human Factors Under Attack?

Dear Editor:

Some of my associates and I were disappointed that no explanation or commentary accompanied the lead-off article entitled "Human Factors and Egg Sucking" which appeared in the February issue of the BULLETIN.

We recognize that Admiral Rickover's memo may be reflective of the attitude which has contributed to attempts to curtail DOD funds for human factors research and development, but the presentation of the memo without any commentary seems to suggest a negativistic attitude toward the prospects for the human factors profession within the DOD.

We would be interested in future commentary regarding the attitudes of the current Congress toward human factors research and development.

Al Hicks

*Your comments and the comments of others on Rickover's letter or human factors in DOD or attitudes in Congress are welcomed and solicited.*

*Lack of editorial comment on Rickover's letter is not a sign that the editor has a negative attitude toward human factors in DOD (or, for that matter, a positive one). The editor is not familiar with the specific program Rickover planned.*

*Nevertheless, it is tempting to defend the name of human factors by attacking Rickover's opinions and hyperbole. Still, some past human factors programs have been good ones and some have been bad. And if we lose interest or ability in recognizing the bad ones, someone else will certainly point them out to our embarrassment. So, automatic support for any program simply because it is labeled "human factors" would be no service to the profession.*

*Who knows what was proposed, that wrought Rickover's wrath? Answer: Those who proposed the program, and those who are otherwise familiar with it.*

*What does the lack of comment from these people mean? Answer: Perhaps they don't read the BULLETIN and, as a result, are missing the opportunity.*—Ed.

## Reports on Better Experimental Methods

Dear Editor:

Thank you for the coverage you gave my "Analysis of Human Factors Engineering Experiments" in the March 1977 BULLETIN. Two points need clarification.

If your readers wish hard copies of any of the reports cited, they should *not* write to me for them since in general my supply is depleted. They are available, however, from the usual distribution agencies such as DDC, ERIC, and NTIS.

I hope that the review does not cause the readers to believe that I am only offering negative criticism. For the major problems I've noted, I have also proposed alternative approaches and solutions which have appeared in other reports written for the

"advanced methodologies" program. Although these published reports tend to be about two years behind the state of the art (in so far as the knowledge I've gained from my investigations), I have tried to close that gap by means of seminars, which to date have been given primarily to Air Force and Navy research organizations.

Charles W. Simon

## Plusses for Harrigan's Book

Dear Editor:

A number of readers of both *Human Factors Program for Architects, Interior Designers and Clients* by John and Janet Harrigan and Malcom Brookes' review felt we were unfairly treated. Not in the least. Malcom like other reviewers helps authors identify shortcomings in their work. When Malcom states, "The authors have fallen between the two stools of too little and too much, to the extent of creating a publication which aligns more closely with Robert Propst's superficial promotion of Herman Miller furniture company..." I agree. I now have something to rest my elbows on while I move to the next step in my work. However, why Malcom found it necessary to take a swipe at an innocent bystander, Robert Propst, who has contributed a great deal toward making human factors applications in interior architecture an area of increasing interest to the design professions, I really don't know.

I do wish to share with you a comment by a former president of the Human Factors Society. This may please those who objected to Malcom's review. "Your monograph represents a great deal of work overall and constant focus on your intended users. I am sure you faced a multitude of decisions on such things as: (1) Should I include this topic? If so, how do I approach it for my targeted audience (e.g., not 'talking down' to them). (2) How deeply should I go in treating a topic to stimulate reader's interest sufficiently to achieve action but avoiding information overload?

"In his review, Brookes in the HFS BULLETIN has erred I think in failing to keep continuously in mind these very things relating to the characteristics and initial needs of the reader/user. It is my fervent hope that your contribution will make real to thousands of citizens what human factors can do for them in designing built environments they need and want. I wish we could find funding to provide a copy to every school board, PTA, city council, county board of supervisors, architect, contractor, state legislature, Congress, building inspectors, and on and on!" I would add students of architecture, landscape architecture, interior design, interior architecture, and city planning.

John E. Harrigan

## Standards for Computer Interfaces

Dear Editor:

To your knowledge, has anyone had any experiences (good or bad) with attempts to develop



standards for the operator-executive/operating system interface? Specifically, the features of this interface with which I am concerned are

- error message formats
  - means of highlighting CRT items which are operator-modifiable, (e.g., an asterisk)
  - means of detecting and providing knowledge of results of keyboard errors
  - input prompting techniques
  - data formatting
- and so forth.

The concern is that, for example, a computer operator with three operating systems, loaded and running, would have an identical error (an incomplete operator command) called three different things.

In designing hardware items, we have all kinds of design guides, handbooks, and military specifications, to ensure that this does not happen—that an identical overtemperature fault in three different cabinets is not called “OVERTEMP/FAULT/UNIT OFFLINE.” All of these conditions may exist, but this can only confuse a technician and lead him to believe that these conditions are indeed different kinds of faults.

I have written to the MIL-STD-1472 committee

and the secretary of the Computer and Business Equipment Manufacturers Association, asking for comments of this situation, but have received none to date. I have a feeling that such standards are not considered as being wholly desirable by many in the data processing business. I do know that without them, human factors people must rely on “best judgement” or a similar “seat-of-the-pants” rationale.

I would be interested in hearing from anyone who has had some experience with developing such standards.

John Dinan  
Raytheon Co., Box CC-23  
Equipment Division  
430 Boston Post Road  
Wayland, Mass. 01778, USA.

*Some years ago IEEE and ANSI had a group working on standards for human-computer interfaces. Evidently the group is still at it, or perhaps they have given up. For some reason, that group chose to concentrate on hardware factors, viewing human factors as esoteric and subject to opinion and, therefore, not amenable to standardization.*

*So much remains to be done.—Ed.*

## Ergonomics & Design Workshops

Arrangements are being made to hold a series of two one-day workshops at the Royal College of Art on the relationship of ergonomics and design. The first of these workshops will involve a meeting of six practicing ergonomists closely involved with designers and the design profession. The object of this first meeting, to be held at the College this month, will be to identify current problems in the relationship between ergonomics and design in the United Kingdom.

The second workshop, scheduled for later this year, will throw the discussion open to leading industrialists, educationalists, and design practitioners.

The object of the series of workshops is to identify actions which could be taken to improve the relationship between the disciplines. For further information contact John Wood, Department of Design Research, Royal College of Art, Kensington Gore, London SW7, England.

## ANNUAL MEETING

### Meeting Plans Take Shape



Abstracts have been flowing in to our program chairperson, and the paper screening committee members are busily reviewing paper and workshop ideas. The program is beginning to take shape under the meeting theme: “Human Factors—Gateways to the Future.” Notification of accepted papers will be sent by May 1st, and a full copy of these papers will be due by June 1st for inclusion in the meeting proceedings.

#### Special Events

Bob Heald, chairperson for special events, has been busily arranging for activities which optimally utilize the unique qualities of “Everybody’s Favo-

rite City.” One of the most exciting of these is a cocktail party and cruise of San Francisco Bay aboard an 18-meter motor yacht on Monday evening, October 17. It may be the only opportunity to get away from it all and to relax with colleagues over a refreshing drink and hors d’oeuvres while enjoying the sights around the Bay. All this pleasure will cost only about \$10 per person if everyone participates. So plan on coming to San Francisco early enough to enjoy this unique and enjoyable experience of a San Francisco Bay cruise.

#### Exhibits

A beautiful indoor garden patio within the Sheraton Hotel at Fisherman’s Wharf has been reserved for exhibit display space. It is located adjacent to the main meeting rooms and will also be the site of all coffee breaks. There is an ad in this issue of the BULLETIN describing the exhibit and advertising options for you to consider. We urge all to participate in making this a successful meeting.

# Human Factors in Consumer Product Design

May Symposium near Oxford, Ohio

A symposium on "Human Factors in Consumer Product Design," sponsored by the consumer products group of the Human Factors Society, will be held on May 2nd and 3rd, 1977. The symposium site will be Hueston Woods Lodge, located in Hueston Woods State Park, near Oxford, Ohio.

Keynote speaker for the symposium will be Lewis Hanes, past president of the Human Factors Society, presently with Westinghouse Research Laboratory in Pittsburgh, Pennsylvania. Hanes will speak on "Consumer Product Humanization."

Two technical sessions and five workshops are scheduled. The first technical session, on May 2nd, will cover "Human Factors and Consumer Products: Case Studies" and include the following papers:

"Human Factoring 'Feel' Into a Product," by John G. Kreifeldt (Tufts University)

"Asleep at the Wheel," by Jack Hockenberry (Steelcase, Inc.)

"Case Study: Seven Infant Care Product Concepts Developed Through Human Factors Research," by Thomas Cannon (Design Factors)

"An Evaluation of Hand-Held Hair Dryer Design: 1. The use of Epidemiological Reports. 2. The Effects of Configuration on User Biomechanics," by Chuck Mauro (Charles Mauro & Associates)

Papers to be presented at the second technical session, on May 3rd, will be under the heading "Human Factors and Consumer Products: Methods." The papers are as follows:

"Generic Approaches to Product Improvement Research," by John V. Fechter (National Bureau of Standards)

"Articulated Anthropometric Scale Models in Consumer Product Design," by Robert P. Meyer and Jack I. Laveson (Design Plus)

"The Interpretability of Consumer Machines," by Malcolm Ritchie (Wright State University)

"Electromyographic Evaluation of Consumer Products," by H. Bradley Hammond (University of Cincinnati)

The following workshops will be held during the symposium:

1. "Retrieval and Adaptation of Human Factors Information," chaired by members of the HFS consumer products group.
2. "Organizing a Human Factors Program for Industry," chaired by A. Le Cocq, S. Robinson, and J. Burnett (Texas Instruments, Inc.)
3. "Communicating the Role of Human Factors as a Discipline," chaired by George Whittington (Argonne National Laboratory)
4. "Product Liability and Safety," chaired by Frank D. Fowler (Fowler, Fuehrer, & Associates)
5. "Federal Agencies and the Consumer Product," chaired by individuals from the Consumer Product Safety Commission and the National Bureau of Standards.

Fees for those attending the Symposium will be \$40 for members of the consumer products group, \$45 for nonmembers and \$15 for students.

Accommodations for persons attending the Symposium will be available at Hueston Woods

Lodge. Camping facilities are also available in Hueston Woods State Park.

A brochure on the Symposium program and accommodations may be obtained from H. Bradley Hammond, Department of Industrial Design, University of Cincinnati, Cincinnati, Ohio 45221, USA.

## HFS Fellows Invited

### June 15 Deadline

If you are one of the 107 HFS fellows in good standing, you are invited to recommend other HFS members (full members, not associates or student members) for elevation to HFS fellow status. The deadline for 1977 nominations is June 15; earlier nominations will be welcomed.

The eight criteria of eligibility for fellow status were published in the February BULLETIN; these criteria and forms for nominations are available from

Fellows Selection Committee

Human Factors Society

P. O. Box 1369

Santa Monica, California 90406, USA

To nominate a member, a fellow in good standing must:

1. Fill out a nomination form,
2. Send out and collect recommendation forms from three other fellows in good standing who support the candidate,
3. Collect samples of publications or other documents indicating outstanding contributions by the candidate to the field of human factors, and
4. Mail the forms and other items described above to the address above for receipt by June 15, 1977.

Nominees must first be approved by the fellows selection committee and then by a two-thirds vote of current HFS fellows. Finally, a majority vote of the HFS executive council is required.

Names of all current HFS fellows were published in the February BULLETIN. The members of the 1977 fellows selection committee are Chuck Hopkins, Bob Mackie, Stu Parsons, Sid Smith, and Ken Teel (chairman).

## Executive Council to Meet

### In San Diego, May 5 & 6

Fred Muckler, HFS president, has called for the "mid-year" council meetings to be held May 5 & 6 at the Navy Personnel Research and Development Center in San Diego. All interested HFS members are cordially invited to attend; members planning to attend must arrange for a visitor's badge by April 29 by writing or calling

F. A. Muckler, Code 311

Navy Personnel R&D Center

San Diego, California 92152, USA

(714) 225-6500 or (714) 225-6617

Prior to the council meetings, the finance and budget committee will meet Wednesday evening, May 4.



## CALENDAR

**April 18, 1977**

**London, England**  
Workshop on ergonomics and design, *Royal College of Art*; John Wood, Design Research Dept., Royal College of Art, Kensington Gore, London SW7, England.

**April 23, 1977**

**Pomona, California, USA**  
Conference on "Spectrum of Liability"; *American Society of Mechanical Engineers* and others; Martin Schwartzbach, 130 Lexington St., Upland, Calif. 91786, USA.

**May 2 & 3, 1977 \* \* \* \* \*** **Oxford, Ohio, USA**  
Symposium on "Human Factors in Consumer Product Design," *HFS Consumer Products Group*; Robert Meyer, 141 Meadowlark Dr., St. Louis, Mo. 63141, USA.

**May 2-6, 1977 \* \* \* \* \*** **Columbus, Ohio, USA**  
International Conference on Skid Prevention, *Transportation Research Board*, with participation by the *Human Factors Society*, TRB, National Research Council, 2101 Constitution Ave., N.W., Washington, D.C. 20418, USA.

**June 1-3, 1977**

**College Station, Texas, USA**  
Seminar on "Work Measurement/Evaluation," *Texas A&M University*; J.K. Hennigan, Industrial Engineering Dept., Texas A&M, College Station, Texas 77843, USA.

**June 6-10, 1977**

**College Station, Texas, USA**  
"Facilities Design Workshop," *Texas A&M University*; J.K. Hennigan, Industrial Engineering Dept., Texas A&M, College Station, Texas 77843, USA.

**September 4-10, 1977**

**Istanbul, Turkey**  
International Conference on Disaster Housing; *Building Research Institute of Turkey* and others; Secy., Disaster Housing Conference, Building Research Institute, Hosdere Cadessi, 212, Cankaya, Ankara, Turkey. (Abstracts invited through April 15.)

**October 17-21, 1977 \* \* San Francisco, California, USA**  
"Human Factors-Gateways to the Future," 21st Annual Meeting; *Human Factors Society*; Warren Badger, HFS Annual Meeting '77, P.O. Box 923, Saratoga, Calif. 95070, USA. (Abstracts invited through March 15. More information elsewhere in this issue.)

**November 6-11, 1977**

**Antalya, Turkey**  
Symposium on "Behavioral Consequences of Crowding," *NATO and Middle East Technical University*; R.B. Bechtel, ERDF, 2030 E. Speedway No. 116, Tucson, Ariz. 85719, USA. (Abstracts invited through April 15.)

## BULLETIN Editor Sought

**June 1 Deadline for Nominations, Volunteers**

John Holly, current editor of the BULLETIN, has announced his intention to resign the post at the end of 1977, after four years of service. The new editor will be selected by the HFS publications board and approved by the executive council earlier in 1977 in order to minimize problems of transition. He or she will assume full responsibility with the first issue of volume 21: January 1978.

You are invited to volunteer your own name or the name of another HFS member for consideration. Candidates from the Los Angeles area would benefit from involvement in the publication process during the latter part of 1976, but consideration of candidates will not be limited to the L.A. area.

Send your resume or nominations to Edmund T. Klemmer, HFS Pubs. Board Chairman, P.O. Box 1369, Santa Monica, Calif. 90406, USA, or call Ed at (201) 949-6692.

### HUMAN FACTORS

Calspan Corporation has an excellent opportunity available in its rapidly growing Human Factors Section.

We seek an individual experienced in:

#### DESIGN OF MAN-MACHINE INTERFACES PROGRAM DEVELOPMENT

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The ideal candidate would have a strong academic background in human performance measurement at the Masters or Doctorate level plus several years of similar experience and proven ability in program development.

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**CALSPAN CORPORATION**  
**P.O. Box 235**  
**BUFFALO, N.Y. 14221**

### Promote Your Very Best in San Francisco



Put your best foot forward. Don't wait until next year. Send today for more information on ads and exhibits at the 1977 HFS Annual Meeting, October 17-20.

Please send me more information on

- Ads in the proceedings and program. Full page, \$100; half page, \$60.
- Coffee breaks. Full credit sponsorship, \$225; cosponsorship, \$75.
- Exhibit space. \$100 for 6-ft. wide table with chairs.

One free meeting registration for each \$150.

name \_\_\_\_\_

address \_\_\_\_\_

\_\_\_\_\_

( ) \_\_\_\_\_

phone \_\_\_\_\_

Mail to John Biggar, Lockheed O/62-05, B/151, P.O. Box 504, Sunnyvale, CA. 94088, USA by May 30.

HUMAN FACTORS SOCIETY  
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Dayton, OH 45424

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## Human Factors Scientists

New positions have been created for Human Factors Engineers at Midwestern and Eastern locations of the NCR Corporation.

**The Position:** Determine human interface requirements for business equipment and systems. Work directly with advanced development and product engineering groups to incorporate human interface requirements into products.

**Qualifications:** Requires the ability to work independently. A master's degree or the equivalent preferred plus related Human Factors work experience. Knowledge of statistics and experimental methodology is necessary. Experience with business equipment products helpful. Understanding of human/software interaction desirable.

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Table 4  
Craft Skill Career Fields

Number	Title
30	Communications-Electronic Systems
31	Missile-Electronic Maintenance
32	Avionics Systems
42	Aircraft Accessory Maintenance
43	Aircraft Maintenance
44	Missile Maintenance
46	Munitions/Weapons Maintenance
47	Vehicle Maintenance
53	Metalworking
54	Mechanical/Electrical
55	Structural/Pavements
56	Sanitation



September 22, 1974. These career fields, therefore, have been deleted from further consideration in this study.

#### Description of the Population

The target population for this study consisted of those WAF in the craft skill career fields who use tools and equipment on a regular basis. The Air Force Specialty Code (AFSC) was the device used to identify these WAF.

The AFSC is a numerical designator used to indicate the career field, the particular specialty, and the level of proficiency of Air Force personnel. The AFSCs of Air Force enlisted personnel consist of five numerical digits. The first two digits indicate the career field in which an individual is trained. The third and fifth digits indicate specialized areas within each career field. The level of proficiency which the individual has attained is indicated by the fourth digit of the AFSC. The proficiency levels are identified by the numbers 1, 3, 5, 7, and 9 to indicate progressively increasing proficiency. The AFSC 47251 is an example; the first two digits, 47, indicate that the individual is in the Airman Vehicle Maintenance Career Field; the third digit, 2, indicates that the airman is in the specialized area of general purpose vehicles; the fifth digit, 1, indicates that the airman is further specialized in body and fender repair; and the fourth digit, 5, indicates that the airman has achieved a 5-level of proficiency. It was this proficiency level portion of the AFSC which was used to identify the normal users of tools



Table 5  
WAF in Craft Skills

Craft Skill Career Field	Number of WAF in the Career Field	Total Number of Personnel in the Career Field	Percentage of Career Field Personnel that are WAF
30	644	36,478	1.8
31	150	7,684	2.0
32	669	33,478	2.0
42	530	23,699	2.2
43	1,445	72,846	2.0
44	46	2,733	1.7
47	3	5,863	.1
53	139	8,428	1.6
54	137	12,752	1.1
55	75	12,605	.6
Total	3,838	216,566	1.77

and equipment in the craft skills.

The target population for this study was identified as the WAF in the craft skill career fields who had a 3 or 5-level of proficiency on September 22, 1974. The number of WAF possessing these proficiency levels in each craft skill is listed in Table 6. The decision to limit the target population to only the 3 and 5-level WAF was made because these were the WAF who were most likely using the craft skill tools and equipment on a regular basis.

Supervisory personnel<sup>1</sup> were eliminated from the target population because their primary duties would not ordinarily require them to use hand tools and equipment on a continuing basis. Additionally, WAF assigned to supervisory duty in the craft skill AFSCs would be cross-trainees from other skills and they would only have a limited knowledge of the specialized tools and equipment used in the craft skills. This assumption is made because women have been permitted in the craft skills for only 24 months, and this is not normally enough time to progress to the supervisory level within a skill.

Helpers<sup>2</sup> were also eliminated from the target population because the craft skills require the completion

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<sup>1</sup>Supervisory personnel are operationally defined as those WAF with a 7 or 9-level of proficiency in a craft skill.

<sup>2</sup>Helpers are operationally defined as those individuals who have achieved only a 1-level of proficiency in a craft skill.

Table 6  
Study Population

Career Field	Number of 3 and 5-Level WAF
30	138
31	28
32	112
42	200
43	743
44	17
47	2
53	64
54	50
55	41
Total	1395

of a formal training course prior to entry into the field. These formal training courses award a 3-level of proficiency upon completion. Thus, helpers would not normally have the practical experience necessary to evaluate the adequacy of the tools and equipment.

#### Data Gathering Methodology

Selection of an instrument. Prior to deciding on a self-administered questionnaire as the data gathering instrument for this study, secondary sources such as governmental or institutional records and published research studies were reviewed to determine if sufficient information was already available for this study. The only information available from such sources were the ages of the WAF in the target population. This information was obtained through the ATLAS inquiry system along with the names and organizations of the WAF in the target population. No other information was available from secondary sources. The information needed to answer the research question was possessed only by the WAF working in the craft skills. The geographic dispersion of the target population made the use of interview or observation techniques prohibitive. The use of such techniques would be too time consuming and inefficient (11:10).

Sample size. A census of the population was attempted rather than a sample because of the small number of WAF in some of the craft skills. Six of these ten



skills contained less than 100 WAF. Consequently, the method decided upon for gathering the necessary information for this study was to conduct a census of the entire population by using self-administered questionnaires.

The questionnaires. The questionnaires contained three major sections. Section I, which was the same for all of the questionnaires, contained five anthropometrically oriented questions. A copy of this section of the questionnaires is contained in Appendix A. Section II of the questionnaires contained a list of tools for evaluation. This section of the questionnaires differed for each career field because of the different tools and equipment used in each field. Copies of section II of each of the questionnaires are contained in Appendices B to K. Section III, which was the same for all of the craft skills, provided space for the WAF to explain their evaluations of the inadequate tools and to add other comments if they so desired. A copy of this section of the questionnaires is contained in Appendix A.

Questionnaire-Section I. The first section of the questionnaires was developed to gather anthropometric information from the target population that was not available from secondary sources. The WAF themselves were considered the only valid source of this information.

The first question in this section asked the WAF to categorize their entry into the craft skills. The

possibility was recognized that WAF who voluntarily entered the craft skills may respond differently to the tool evaluations than the WAF who did not volunteer. The volunteer category was divided into two responses (a and b) to recognize the possibility that an overriding reason, namely entering the Air Force, may have influenced the WAF to volunteer for the craft skills.

The second, third, and fifth questions were asked so that data could be gathered on the physical dimension ranges of the population. This data was to be tabulated in a manner similar to the way in which data was tabulated in the anthropometric study of the medical and administrative women. These tabulations were considered important for future studies. For example, if this study identified any tools or equipment as inadequate for women, what dimension ranges should be considered in the redesign of such tools or equipment? The dimension ranges developed from the responses to questions 2, 3, and 5, could help determine whether the ranges of medical and administrative women could be used or if a new anthropometric study should be made of the WAF in the craft skills.

The Air Force has classified all AFSCs according to lifting requirements (23A57-1-A57-3). The fourth question in this section asks the WAF to classify their tool boxes in a similar manner. Since the tool box is frequently one of the heaviest items that maintenance personnel regularly lift, the responses to this question could help validate

the Air Force's AFSC lifting classifications.

Questionnaire-Section II. The objective of this section of the questionnaires was to determine which tools, if any, the WAF considered to be inadequate. They were asked to evaluate the adequacy of their tools and to express their evaluations by placing their tools into one of three categories. The first category indicated that they considered the tool to be "superior." This classification showed that they considered the tool versatile, efficient, or preferred. The second category indicated that the WAF considered the tool to be "adequate." This classification showed that they thought the tool was effective, worthwhile, or useful. The third category indicated that the women considered the tool to be "inadequate." This meant that they considered the tool inappropriate, awkward, or difficult to manipulate. A fourth classification was added to allow the WAF to indicate that the tool was "not issued."

The structured response approach was taken in this section of the questionnaires to increase the control over the respondents' answers (6:214). The definitions for the tool categories were developed to clarify the qualitative variable of tool adequacy for the WAF respondents. Each of the descriptive words was chosen to denote a characteristic that could be applied to the category and to the tool. These descriptive words were chosen so that they could be readily understood by everyone in the target population. The high school graduate level was chosen for this



understanding because a high school diploma is a requirement for all women before they can be accepted into the Air Force.

The tool lists used in this section of the questionnaires were developed from lists provided by the 2750th Air Base Wing, Materiel Division, Tool Issue Branch (DMSESI), Wright-Patterson Air Force Base, Ohio. Tool lists for the Missile Maintenance Career Field (44), however, were not available at Wright-Patterson. Thus, they were obtained from the 321st Supply Squadron, Grand Forks Air Force Base, North Dakota. The tool lists provided by these organizations were consolidated into a single tool list for each career field. To compensate for any variations that may occur between tool kits issued at different bases, a question was added at the end of the tool list to allow the respondent to list any additional inadequate tools that were not listed.

Questionnaire-Section III. The third section of the questionnaires was added to allow the respondents to add any additional information they considered necessary to help explain their categorization of each inadequate tool. The information gathered from this section of the questionnaires was required to provide a basis for future studies. This information is particularly important in the validation of the inadequacies experienced by WAF using their present tools and equipment.



### Ambiguity and Validity

Ambiguity in the questionnaires was reduced by using terms that the respondents should readily understand and by using only short questions and definitions (6:220). Further, the questionnaires were tested on the WAF in the craft skills stationed at Wright-Patterson AFB, Ohio. Interviews with these WAF after they had answered the questionnaires revealed that they had no problems in understanding or responding to any of the questions.

The potential validity of the questionnaire as an anthropometric data gathering instrument was reviewed by Dr. Charles E. Clauser and Mr. Kenneth W. Kennedy, Research Physical Anthropologists, Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio. Dr. Clauser and Mr. Kennedy were instrumental in compiling the anthropometric data on the women in the medical and administrative skills. The suggestions of Dr. Clauser and Mr. Kennedy were incorporated into the questionnaires.

### Data Collection Plan

The data required to complete this study was collected from two sources: (1) the ATLAS personnel inquiry system and (2) the questionnaires completed by the WAF respondents. The ATLAS system provided a listing which contained the name, AFSC, organization, and date of birth for each WAF in the craft skills. From this listing, the names and organizations of the 3 and 5-level WAF were extracted and questionnaires were sent to these women.

The date of birth of all the WAF in the craft skills was used to determine the age distributions of the universe and the target population. A listing of these age distributions is contained in Appendix L along with the age distribution of the WAF in the medical and administrative skills from the earlier anthropometric study.

The data extracted from the returned questionnaires was used to determine the adequacy of the tools and equipment used by the respondents and to develop physical dimension ranges for the height, weight and hand size of the target population. Tally sheets were developed for each craft skill to record the number of questionnaires returned in that skill and the tools that were listed as inadequate on each questionnaire. When the returned questionnaires had all been recorded on the tally sheets, the adequacy of each tool was determined according to the decision rule stated in the next section of this chapter. The height, weight, and hand size of the respondents were recorded on separate tally sheets. These measurements were not segregated by craft skill because of the small target populations in many of the craft skills, and because the original anthropometric study did not differentiate the target population by AFSC. When these measurements from the questionnaires had all been recorded, the height, weight and hand length distributions were developed. These distributions are listed in Appendices M to O along with the corresponding distributions from the earlier anthropometric study of WAF.

In this study, the comments from Section III of the questionnaires were used only to determine the reasons the respondents considered a tool inadequate. These reasons could also be used in later studies to validate the tool inadequacies and investigate possible modifications to the tools and equipment.

#### The Decision Rule

The Human Engineering Guide for Equipment Design recommends that tools and equipment be designed to meet the dimensional ranges of the using population from the fifth to the ninety-fifth percentile (25:469-471, 534-542, 551-571; 5). Stated in another way, the tools and equipment should be adequate for at least ninety percent of the population. Consequently, the following decision rule was adopted for this study:

IF MORE THAN TEN PERCENT OF THE WOMEN IN A PARTICULAR CRAFT SKILL CONSIDERED A TOOL INADEQUATE THAT TOOL WILL BE CONSIDERED INADEQUATE.



## CHAPTER 4

### ANALYSIS OF RESULTS

#### Introduction

This chapter contains the analysis of the data collected during this study. The first section of the chapter discusses the response rate to the questionnaires, the second section presents the inadequate tools and equipment identified by the respondents, the third section provides an analysis of the anthropometric data obtained from the questionnaires, and the fourth section discusses some of the general comments that were made by the respondents about the overall quality of tools and equipment and the appropriateness of the craft skills for women.

#### Response Rate

On November 5, 1974, a total of 1,395 questionnaires were mailed to the target population of 3 and 5-level WAF in the ten craft skills identified in this study. Although the WAF were given seven days after receipt of the questionnaires to complete and return them, responses continued to be received until December 20, 1974. As of that date, 649 questionnaires or 46.52 percent of all questionnaires had been received. The individual response rates for each craft skill varied from a low of 41.12 percent to 100 percent. The response rate for each craft

skill is listed in Table 7.

One of the assumptions made in this study was that the tool evaluations provided by the respondents represented the views of the WAF working in the craft skills. To minimize the potential bias of sampling, a census of the target population was attempted. No control device was used so that the respondents could remain completely anonymous. Although a control device could have helped explain why more WAF did not answer the questionnaires, it was felt that a control device might also inhibit some WAF from freely expressing their opinions. The candidness of many of the responses indicated that the respondents did feel that they could comment freely about the tools and equipment items listed, and also about additional problem areas which they felt deserved consideration. No reason could be established for an overall response rate of only 46.52 percent; however, a response rate of only 20 to 42 percent is considered normal for uncontrolled studies (8). It is not known whether the WAF that failed to respond did so because they had no difficulty with the tools and equipment they used, or they did not think answering the questionnaires would do any good in eliminating the difficulties they have with their tools and equipment.

#### Inadequate Tools and Equipment

Each craft skill had at least one tool or equipment item that was considered inadequate by ten percent or more of the respondents. These items are listed in Table 8.

Table 7  
Questionnaire Response Rates

Career Field	Number of Questionnaires		Response Rate
	Mailed	Returned	
30	139	81	58.3%
31	28	18	64.2%
32	112	61	54.5%
42	200	87	43.5%
43	741	305	41.12%
44	18	10	55.6%
47	2	2	100.0%
53	64	30	46.9%
54	50	27	54.0%
55	41	28	68.3%
Total	1395	649	46.52%



Table 8  
Inadequate Tools and Equipment

Career Field	Item	Percentage	Comments
30 (Comm-Elec)	Work Shoes*	28.8	Too big; too heavy; not shaped for women
	Soldering Iron*	17.3	Too heavy; handle too large; cord too short
	Soldering Gun	15.3	Too heavy; can't reach trigger; hard to hold in hand
	Crimping Tool*	13.5	Handles too far apart; too hard to squeeze
	Wire Stripper*	11.5	Hard to hold in hand; handles too far apart to squeeze
31 (Miss-Elec Maint)	Twist Wire Pliers	29.4	Too large to grip; handles too far apart; too long
	Wire Stripper*	17.6	Too large to grip properly; too heavy; clumsy
	Crowfoot	11.8	Awkward
	Flexible Mechanical Finger	11.8	Hard to manipulate
	Air Pack	11.8	Too heavy
	Work Uniform*	11.8	Poor fit; not warm enough; impractical
	Clamp Shell	11.8	Too heavy
32 (Avionics)	Work Shoes*	20.3	Too large; do not fit correctly
	Wire Stripper*	18.6	Hard to manipulate; too hard to squeeze

Table 8 (continued)

Career Field	Item	Percentage	Comments
	Soldering Iron*	15.3	Clumsy; too bulky; hard to handle
	Crimping Tool*	13.6	Hard to manipulate; grip too wide
	Work Uniform*	15.3	WAF fatigues stain easily; Male fatigues ill-fitting and uncomfortable
42 (Acft Acc Maint)	Crimping Tool*	25.3	Not physically able to manipulate
	Wire Stripper*	14.7	Too big for my hand; handle too wide
	Work Shoes*	13.3	Too wide at ankles; not small enough
43 (Acft Maint)	Ear Protectors	11.7	Too big; hurt my head; won't stay on
	Goggles*	10.9	Won't fit with glasses; fog up too easily
	Work Shoes*	10.5	Impossible to get; dig into arch and ankle
44 (Miss Maint)	Breaking Bar	14.3	Too heavy
	Speed Handle	14.3	Too slippery
	Work Uniform*	14.3	Get torn too easily
	Goggles*	14.3	Can't see through them due to fog
47 (Veh Maint)	Goggles*	100	No comments
53 (Metal- Working)	Metal Shears	21.7	Too large; need two hands to cut
	Goggles*	17.4	Can't see due to fog and distortion

Table 8 (continued)

Career Field	Item	Percentage	Comments
	Rivet Cutter	17.4	Too hard to squeeze; awkward
54 (Mech/ Elec)	Wire Stripper*	18.2	Hard to grip; fingers get pinched; hard to cut
	Goggles*	13.6	Hair gets caught; don't fit
	Portable Tool Box	13.6	Too big, clumsy and heavy
55 (Struct/ Pave)	Goggles*	15.8	Hard to see (steam)
	Carpenter's Tool Chest	15.8	Too heavy
	Jack Plane	15.8	Too big
	Caulking Gun	10.5	Hard trigger; awkward
	Key Hole Saw	10.5	No comments
	8 oz. Hammer	10.5	Too heavy
	Glass Cutter	10.5	No comments

\*Denotes common inadequate tools and equipment.

This table also lists the percentage of respondents that considered the tool inadequate and a sample of the reasons given for its inadequacy. The items followed by an asterisk (\*) in Table 8 indicate that they were identified as inadequate in more than one craft skill. Since these items were judged inadequate for more than one craft skill, they will be termed, "common inadequate tools and equipment." The common inadequate tool and equipment items are considered to have a more serious adverse impact on the performance of WAF in the craft skills. Consequently, these items will be discussed individually. Limiting the discussion to only the common inadequate tool and equipment items should not be construed as an implication that the inadequacies of the remaining items are of lesser importance. It simply means that the common inadequate tools and equipment have a greater impact and therefore deserve greater discussion.

Common inadequate tools. Two of the three common inadequate tools, the crimping tool and wire stripper, had very similar reasons offered for their inadequacy.<sup>1</sup> Some of the respondents stated that they needed two hands to squeeze the tool; thus, they needed a third hand to hold the wire.

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<sup>1</sup>The crimping tool was identified as inadequate in the Communication-Electronics, Avionics, and Aircraft Accessory Maintenance craft skills. The wire stripper was also identified in these three craft skills as well as in the Missile-Electronics and Mechanical/Electrical craft skills.



Others stated that the grips were too wide for a woman's hands. An analysis of the hand length of the respondents that identified the crimping tool and wire stripper as inadequate showed that they had an average hand length of 6.8 inches. When this hand length is compared to the hand length of Air Force men (the average hand length of male Air Force personnel is 7.76 inches), the reason women had problems with these tools is obvious; these tools were designed for men (10:1,9). What is more significant is that less than one percent of Air Force men have a hand that is as short as the average WAF hand. Thus, it is easy to see why a crimping tool or wire stripper which fits the hands of most Air Force men would be too large for a WAF mechanic.

The third common inadequate tool identified was the soldering iron. This tool was judged inadequate by WAF in the Communication-Electronics and Avionics Systems craft skills. The reasons for the inadequacy of the soldering iron were given as: it is too heavy, its handle is too large and it is just too hard to handle. The average hand length of the WAF that considered this tool to be inadequate was 6.7 inches, even smaller than the WAF that considered the crimping tool and wire stripper inadequate.

Grip strength is one of the most important variables used in the design of hand tools such as the crimping tool, wire stripper and soldering iron, but this variable cannot be readily obtained from a self-administered questionnaire.

Age, height, weight, and hand size, however, are all important variables from which grip strength can be estimated (9:22,33,43,56). These variables were obtained from the respondents so that they could be used in later studies. The general profile of the WAF who were using the crimping tool, wire stripper and soldering iron in the craft skills showed that they were shorter, they weighed less, and they had smaller hands than the men for whom these tools were designed. These differences suggest that the grip strength of these WAF may also be less than the grip strength of their male counterparts. Thus, one could infer that the WAF who use these tools would have more problems than the men who use them.

Common inadequate equipment. Three common equipment items were identified as inadequate for women in the craft skills. These equipment items were goggles, work uniforms and work shoes. It is important to note that work uniforms and work shoes were not listed on the questionnaires, but were added by the respondents in the area reserved for additional items in Section II of the questionnaires.

Goggles were found inadequate by WAF in the Aircraft Maintenance, Missile Maintenance, Vehicle Maintenance, Metalworking, Mechanical/Electrical, and Structural/Pavements craft skills. The women in these craft skills stated that the goggles distorted their vision, fogged up very quickly, caused glare when used at night, and don't fit properly over glasses. The WAF also had problems with their

hair getting caught in the straps of the goggles. None of these reasons appear to be peculiar to women; therefore, if this inadequacy is equally applicable to men, its correction would be of value to everyone using goggles in the craft skills.

Work uniforms and work shoes, even though not listed on the questionnaire, were identified as inadequate through the added comments of more than ten percent of the respondents. Work uniforms were judged inadequate in the Avionics Systems and Missile Electronic Maintenance craft skills. Work shoes were identified in the Avionics Systems, Communication-Electronic Systems, Aircraft Accessory Maintenance, and Aircraft Maintenance craft skills. Although less than ten percent of the respondents in the other craft skills identified these items as inadequate, both items were mentioned in eight of the ten craft skills.

The work uniforms, both the authorized WAF fatigue and male green fatigue, were judged inadequate because the WAF believed that the WAF fatigue stained too easily and wore out faster than the male fatigue. On the other hand, when they were issued the male fatigue they found these fatigues to be ill-fitting and awkward to wear.

Size was the primary reason given for the inadequacy of work shoes. Comments indicated that WAF could not get work shoes in sizes small enough for their feet. A few women who had obtained issued work shoes complained that they did not fit a woman's foot width or instep. Although



smaller men may have equal difficulty in obtaining work shoes that fit them, the smaller average size of women (average height of 65 inches and average weight 127 pounds) would tend to indicate that this problem would be more prevalent for women. This assumption is supported by the fact that even though a census was not achieved in the Communications-Electronics Systems and Avionics Systems craft skills, the number of respondents considering work shoes inadequate exceeded ten percent of the entire population of WAF in these craft skills.

The adequacy of the tool and equipment items for men was not a subject of this study; however, smaller men could well benefit from the results of this study. The elimination of tool inadequacies experienced by women could help everyone in a given craft skill by causing the redesign of a tool that may be inadequate for everyone. Future studies may indicate that similar problems exist for the smaller male workers in these skills.

#### Anthropometric Data

The General Information section of the questionnaires was developed to gather anthropometric data on the target population. This data could be used to aid future researchers in the validation and redesign of the inadequate tools and equipment identified in this study. A general profile of the WAF in the craft skills was developed from the data collected in the questionnaires and the ATLAS inquiry received from AFMPC. The average age of all WAF in



the craft skills was 21.48 years. Their average height was 64.86 inches (approximately 5 feet, 5 inches), and their average weight was 126.82 pounds. The average hand length of these women was 6.93 inches.<sup>2</sup> The accuracy of the individual height, weight, and hand length measurements is unknown. In the anthropometric study done on WAF in 1968, it was found that WAF underestimated their true weight by an average of 1.9 pounds and overestimated their true height by an average of one inch (4:28). No estimate of true hand length was made. However, even with this uncertain accuracy, the measurements appear to closely parallel the clinical measurements contained in the 1968 anthropometric study of WAF in the administrative and medical career fields. These comparisons are found in Appendices L through O. These comparisons may mean that a new study may not be necessary before beginning tool redesign efforts. The physical characteristics contained in the 1968 study may be appropriate for tool redesign.

The analysis of the question which addressed how the respondents were selected for the craft skills revealed that 52.3 percent of all WAF directly volunteered for the craft skills and an additional 35.4 percent entered the craft skills because they were the only career fields open when they enlisted. Only 9.2 percent of the WAF were chosen for

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<sup>2</sup>In comparison, the average man in the Air Force is 69 inches tall, weighs 164 pounds, and has a hand that is 7.76 inches long (24:481; 10:9).

the craft skills while in basic training and 3.1 percent did not know how they were chosen. This general distribution of reasons predominated in all the craft skills except the Aircraft Maintenance (43) career field. In this career field the top two categories were reversed, 47.6 percent of all WAF entered because it was the only career field open when they enlisted and 44 percent directly volunteered for this career field. From the data collected in response to the question on the approximate weight of the tool box (question 4), it was impossible to validate the Air Force's lifting requirements classification for each AFSC. This question was based on the premise that the tool box was one of the heaviest items an airman would generally lift. This premise proved to be false in many instances. Over 31 percent of all the respondents did not know how much their tool box weighed, or were not issued an individual tool box. Also many of those that did give an approximate weight indicated that it was only a partial weight because their unit was using Consolidated Tool Kits (CTK) and they carried only the tools which they required for an individual job. For these reasons further analysis of this question has been omitted.

#### General Comments

Over 20 percent of all respondents made general comments about their career fields, overall tool quality, the questionnaire, and the Air Force in general. Over half of the comments dealt with two topics: (1) the appropriate-

ness of the craft skill career fields for women, and (2) the overall quality of the tools issued in those career fields. Over seven percent of all respondents commented about women in the craft skill career fields and another four percent commented about the poor quality of tools issued in the craft skills.

The comments the WAF made about the craft skills embraced the full spectrum of, "I love my job" to "I hate this AFSC!" No statistical significance can be attributed to the distribution of comments, because the comments represent only three percent of the entire population. Unfavorable comments, however, were much more prevalent than favorable comments. Of the 46 comments received about the craft skills for women, only four were favorable. The unfavorable comments seemed to center around difficulties experienced in the work environment and the physical requirements women should have before entering these career fields. Here are some of the typical comments WAF in the craft skills made about their career fields:

All the tools were satisfactory--the only thing wrong is the job for women.

All in all, my opinion is that this AFSC (431XX) is not for a lady at all. I do consider myself a lady . . . . I'm not a weakling as I've worked hard most of my younger life. But working with 30 or 50 men can be very hard to live with day after day and also many times embarrassing and depressing.

In my opinion this career field (43XXX) should be limited to men, or women able to cope with this kind of work.



I believe that there should be some kind of standard for WAF going into these AFSCs. The tools, as far as I'm concerned, are no harder to handle for a woman than a man.

Anyway, I don't think women should be in the maintenance fields. The men resent it. I got nothing but trouble when I came down here. I wasn't the only WAF they hassled.

Twenty-eight comments were received about the quality of tools issued in the craft skills. Unlike the previous topic, all of these comments were unfavorable. Here are some of the typical comments about tool quality:

I'm not really dissatisfied with individual tools as much as the quality of the tools I use.

The biggest problem seems to be a lack of quality, especially in ratchets which are continuously jamming up or missing.

The tools are, for the most part, cheaply made which, in itself, renders them inadequate.

I appreciate the concern that someone is finally showing toward the tools we are issued. A lot of the inadequate tools are so because of the underquality brands we are issued.

Although these comments represent the opinions of only approximately two percent of the WAF in the craft skills, the consistency of these unsolicited comments seems to indicate a concern by the respondents for the effectiveness of the tools they are issued. Some of the respondents even offered suggestions on improving the tools.



## CHAPTER 5

### SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

#### Summary of the Problem and Methodology

The United States Air Force considers its people to be its most valuable resource. Consequently, a major consideration in Air Force policy decisions is the development of the full potential of each individual. Over the next five years, a growing number of these individuals will be women. Their role in the Air Force will not be restricted to positions previously stereotyped as women's jobs (i.e., medical and administrative); it will cut across the full spectrum of non-combat specialties within the Air Force (14:27-31).

The tools and equipment now used in the non-combat specialties, e.g., maintenance, electronics, and civil engineering were designed to meet the needs of a totally male work force. These tools may or may not be appropriate for females. Adequate tools are required to develop the full potential of the women who are entering these previously all-male specialties. Therefore, there is a need to determine whether or not the tools and equipment now being used are adequate to meet the needs of women.

A census by self-administered questionnaire was used to gather the data needed to address this potential

problem. A census was attempted rather than a sample because of the small number of WAF in some of the craft skills. A total of 1,395 questionnaires were sent to 3 and 5-level WAF working in the craft skills as of September 22, 1974. A total of 649 responses were received yielding an overall response rate of 46.52 percent. The questionnaires contained three sections. In the first section, the WAF were asked to provide anthropometric data on themselves so that physical dimension ranges could be established. The second section presented the WAF with a list of tools for their skill and asked them to evaluate each of the tools they used as superior, adequate, or inadequate. In the third section of the questionnaires, the WAF were asked to explain their reasons for identifying a particular tool as inadequate. Tools considered inadequate by more than ten percent of the respondents in a particular craft skill were considered inadequate for WAF in that craft skill. The ten percent level was chosen because it is commonly used by human engineers in evaluating the range of tool and equipment adequacy for a given target population.

### Findings

GIVEN THAT THE TOOLS AND EQUIPMENT NOW USED IN THE CRAFT SKILLS WERE DESIGNED FOR MEN AND THAT THE NUMBER OF WOMEN WORKING IN THESE SKILLS IS EXPECTED TO INCREASE, ARE ANY OF THE TOOLS OR EQUIPMENT NOW USED IN THESE SKILLS CONSIDERED INADEQUATE BY WAF?

The answer to the research question is summarized in Table 9. This table lists the tools and equipment items judged inadequate by ten percent or more of the respondents in each craft skill. Three tools and three equipment items were found inadequate in more than one craft skill and were operationally defined as "common inadequate tools and equipment." The three common inadequate tools were the crimping tool, wire cutters, and soldering iron. The common inadequate equipment items were goggles, work uniforms and work shoes. It was also found that the distributions of height, weight and hand length for WAF in the craft skills did not differ appreciably from the same measurements of height, weight and hand length gathered from medical and administrative WAF in a 1968 anthropometric study. Therefore, it may be appropriate to use data from this earlier study in future tool designing.

### Assumptions

The following assumptions have been made in this study:

1. The WAF in the craft skills possess sufficient knowledge of their tools to evaluate the adequacy of them.
2. The word description of each tool in Section II of the questionnaires is sufficient to allow the WAF to identify the tool for evaluation.
3. The superior, adequate, inadequate, and not issued categories of tools are mutually exclusive and collectively exhaustive.

Table 9

## Summary of Inadequate Tools and Equipment

Career Field	Inadequate Items	
30 (Communications-Electronic Systems)	Work Shoes* Crimping Tool* Soldering Gun	Soldering Iron* Wire Stripper*
31 (Missile-Electronic Maintenance)	Work Uniform* Crowfoot Twist Wire Pliers Flexible Mechanical Finger	Wire Stripper* Air Pack Clamp Shell
32 (Avionics Systems)	Work Shoes* Work Uniforms* Crimping Tool*	Wire Stripper* Soldering Iron*
42 (Aircraft Accessory Maintenance)	Work Shoes* Crimping Tool*	Wire Stripper*
43 (Aircraft Maintenance)	Work Shoes* Ear Protectors	Goggles*
44 (Missile Maintenance)	Work Uniforms* Breaking Bar	Goggles* Speed Handle
47 (Vehicle Maintenance)	Goggles*	
53 (Metalworking)	Goggles* Metal Shears	Rivet Cutter
54 (Mechanical/Electrical)	Goggles* Portable Tool Box	Wire Stripper*
55 (Structural/Pavements)	Goggles* Caulking Gun 8 oz hammer Carpenter's Tool Chest	Jack Plane Key Hole Saw Glass Cutter

\*Denotes common inadequate tools and equipment.



4. The returned questionnaires provide an accurate representation of the tool evaluations of all WAF working in the craft skills.

### Limitations

The following limitations have been recognized in this thesis:

1. Since some of the craft skills still have a small number of women in them, all of the inadequate tools may not be identified in these skills.

2. The WAF who do not respond to any of the questions in this study may cause the results to be biased in some manner.

3. The accuracy of the dimensional responses is unknown.

### Conclusions

The objective of this study was to determine if the tools and equipment now used in the craft skills by WAF are adequately meeting their needs. The results have shown that some WAF in these skills feel that there are tools and equipment which do not meet their needs. This study has identified those tool and equipment items. The next step that should be taken is to have the tool inadequacies validated so that the necessary redesign studies could be started.

The adequacy of the present tools and equipment for men was not a subject of interest in this study, but this

subject may influence the direction that future tool design takes. Several of the respondents in this study indicated that the inadequacies that they encountered are also encountered by many of the men who use the same tools and equipment. Some of the inadequacies were associated with the type of weapon system or maintenance environment in which the tool or equipment item was used. These inadequacies were not addressed in this study because they did not singularly apply to women. However, a study of the tool inadequacies that men experience with their tools would help identify the tools and equipment that are inadequate due to the weapon system or maintenance environment in which they are used. Such a study may also reveal that smaller men experience many of the tool and equipment problems that women experience.

Since WAF are being infused in greater numbers into the craft skill work force, the importance of tools and equipment meeting their needs also becomes greater. The Air Force cannot afford to let these women work with tools and equipment that do not meet their needs. Future studies and cost considerations may help determine if the approach used in resolving this problem is to develop special tools for women only or to develop new tools which are suited for both male and female users. Regardless of the approach used, steps need to be taken to develop and acquire tools and equipment that meet the needs of the WAF who are working in the craft skills.

The quality of the tools that are issued to workers in the craft skills was not an item of interest in this study, but four percent of the respondents made adverse comments on the overall quality of the tools they were issued. The efficiency and effectiveness of any work force is affected by the quality of the tools which are used. If, as some of the respondents have indicated, the quality of hand tools issued to them is inferior, their effectiveness on the job will be decreased. Since no special WAF tools are issued, it could be assumed that males in the craft skill might also consider the present tool quality to be inferior. Therefore, it would seem that the overall quality of hand tools issued in the craft skills is another area which should be examined.

Tools alone, however, do not make an effective maintenance organization. The people in an organization are by far the greatest contributing factor in the success of any organization. It was rather surprising for us to receive such a large number of comments from WAF in the craft skills indicating general disillusionment about their career field. Many of the respondents offered comments which indicated that they had second thoughts about the appropriateness of craft skills for women. This is a highly relevant issue because of the increasing number of WAF which will be entering the craft skills in the next five years. By looking only at the anthropometric differences that exist between Air Force men and WAF, we may be ignoring the more

significant potential sociological and psychological problems that may exist. Further exploration into this area may be most important and most beneficial to the Air Force in helping it realize the full potential of every one working in the craft skills.

### Recommendations

Based on the findings and conclusions of this study, the following recommendations are made:

1. Recommend that a study be conducted to validate and possibly modify the inadequate tools and equipment identified in this thesis.
2. Recommend that a study be performed to determine if the tools and equipment issued to personnel in the craft skills are appropriate to meet the requirements of their specific weapon system or maintenance environment.
3. Recommend that a study be conducted to determine the overall quality of hand tools issued to personnel in the craft skills.
4. Recommend that a study be initiated to investigate potential sociological and psychological problem areas in the working environment which WAF may encounter in the craft skills.



## APPENDICES

APPENDIX A  
SECTIONS I AND III OF ALL QUESTIONNAIRES

## APPENDIX A

### SECTIONS I AND III OF ALL QUESTIONNAIRES

#### Section I

Please answer the following five general information questions about yourself:

1. How do you think you were chosen for your present career field? (circle most appropriate letter)

- a. It was the only career field open when I enlisted.
- b. I volunteered for this career field.
- c. The Air Force selected me while I was in basic training.
- d. I don't know.

2. How tall are you? (fill in blanks)

\_\_\_\_\_ feet, \_\_\_\_\_ inches

3. How much do you weight? (fill in blanks)

\_\_\_\_\_ pounds

4. How much do you think your tool box and tools weight?

(circle appropriate letter)

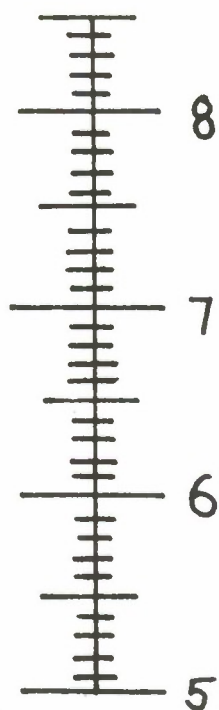
- |                        |                                 |
|------------------------|---------------------------------|
| a. less than 20 pounds | e. over 100 pounds              |
| b. 10-20 pounds        | f. I was not issued a tool box. |
| c. 20-50 pounds        |                                 |
| d. 50-100 pounds       | g. I don't know.                |

5. Please follow the instructions below to indicate your hand length. Remove wrist watches or bracelets before making the measurement.

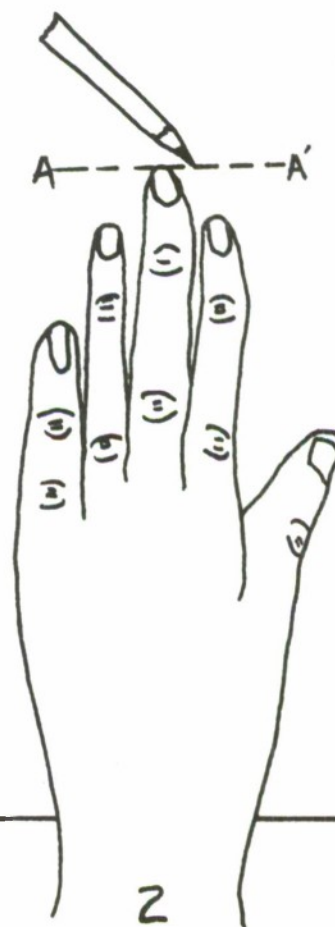
a. Place your left hand on the paper as shown in Figure 1.

b. Turn your hand palm down on the paper. Be sure your longest finger lies on the scale. Make a legible mark on the paper at the tip of your longest finger. (Please use the end of your finger and not your finger nail for measurement.)





PLACE WRIST CREASE  
ON THIS LINE



## Section III

## Additional Comments

This section has been added to enable you to explain why you evaluated a tool as INADEQUATE. Your comments will be invaluable in the redesign of these inadequate tools.

Please make your comments in the following manner. Print the entire name of the tool and then add a brief phrase or two that describes the inadequacies of the tool. Here are two examples:

A. 16 oz. Ballpeen Hammer - Slippery handle

B. Portable Electric Drill - Cord too short; trigger hard  
to reach

[illegible]

APPENDIX B  
SECTION II OF 30XXX QUESTIONNAIRE

## APPENDIX B

### SECTION II OF 30XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Pin Straightener	_____	_____	_____	_____
Crow Foot	_____	_____	_____	_____
Scratch Awl	_____	_____	_____	_____
Masonry Star Drill	_____	_____	_____	_____
Pocket Level	_____	_____	_____	_____
Claw Hammer	_____	_____	_____	_____
Wrecking Bar	_____	_____	_____	_____
Cable Locating Needle	_____	_____	_____	_____
Sq Smooth File	_____	_____	_____	_____
Masonry Drill Handle	_____	_____	_____	_____
Universal	_____	_____	_____	_____
Orange Wood Stick	_____	_____	_____	_____
Pipe Cutter	_____	_____	_____	_____
Wire Unwrap Tool	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Tube Bender	—	—	—	—
Trammel Heads	—	—	—	—
Bar Magnet	—	—	—	—
Battery Powered Handset	—	—	—	—
Chain Nose Pliers	—	—	—	—
Short Nose Pliers	—	—	—	—
Slip Joint Pliers	—	—	—	—
Socket Wrench	—	—	—	—
Socket Set	—	—	—	—
Curved Forceps	—	—	—	—
Jeweler's Nippers	—	—	—	—
Hemostat Forceps	—	—	—	—
Solder Seizer	—	—	—	—
End-Cut Nippers	—	—	—	—
Typewriter Brush	—	—	—	—
Solder Removing Tool	—	—	—	—
Alignment Tool Kit	—	—	—	—
Wire Brush	—	—	—	—
Flat Smooth File	—	—	—	—
Second Cut File	—	—	—	—
Cold Chisel	—	—	—	—
Jeweler's Oiler Set	—	—	—	—
Crimping Tool	—	—	—	—
Socket Extension	—	—	—	—
Half Round File	—	—	—	—
Drive End Handle	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Electron Extractor	_____	_____	_____	_____
Contact Burnisher	_____	_____	_____	_____
Offset Screwdriver	_____	_____	_____	_____
Retaining Ring Pliers	_____	_____	_____	_____
Diagonal Cut Pliers	_____	_____	_____	_____
Steel Rule	_____	_____	_____	_____
Goggles	_____	_____	_____	_____
Tape Measure	_____	_____	_____	_____
Lineman's Pliers	_____	_____	_____	_____
Center Punch	_____	_____	_____	_____
Explosion Proof Flashlight	_____	_____	_____	_____
Twist Drill Set	_____	_____	_____	_____
Test Adapter	_____	_____	_____	_____
Sidehandle Drill Handle	_____	_____	_____	_____
Ballpeen Hammer	_____	_____	_____	_____
Level & Plumb	_____	_____	_____	_____
Lamp Extractor	_____	_____	_____	_____
Mechanical Finger	_____	_____	_____	_____
Desoldering Iron Kit	_____	_____	_____	_____
Screw Extractor	_____	_____	_____	_____
Ratchet Handle	_____	_____	_____	_____
Gap Setting Gauge	_____	_____	_____	_____
Inspection Mirror	_____	_____	_____	_____
Putty Knife	_____	_____	_____	_____
Electrician's Knife	_____	_____	_____	_____
File Handle	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Socket Head Key Set	_____	_____	_____	_____
Electric Soldering Iron	_____	_____	_____	_____
Socket Wrench Set	_____	_____	_____	_____
Wire Stripper	_____	_____	_____	_____
Ratchet Screwdriver	_____	_____	_____	_____
Flat Screwdriver	_____	_____	_____	_____
Taper Tap	_____	_____	_____	_____
Plug Tap	_____	_____	_____	_____
Mechanic's Tool Pouch	_____	_____	_____	_____
Phillips Screwdriver	_____	_____	_____	_____
Electrician's Scissors	_____	_____	_____	_____
Straight Punch	_____	_____	_____	_____
Tweezers	_____	_____	_____	_____
Soldering Aid Tool	_____	_____	_____	_____
Fuse Puller	_____	_____	_____	_____
Jeweler's Screwdriver	_____	_____	_____	_____
Metal Cutting Shears	_____	_____	_____	_____
Needle-Nose Pliers	_____	_____	_____	_____
Soldering Gun	_____	_____	_____	_____
Magnetic Retrieving Tool	_____	_____	_____	_____
Wrench Set, Open-Ended	_____	_____	_____	_____
Hacksaw Frame	_____	_____	_____	_____
Adjustable Wrench Set	_____	_____	_____	_____
Pipe Strap Wrench	_____	_____	_____	_____
Tap & Ream Wrench	_____	_____	_____	_____
Penlight Flashlight	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Sharpening Stone	_____	_____	_____	_____
Drill Set	_____	_____	_____	_____
Tool Box	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



APPENDIX C  
SECTION II OF 31XXX QUESTIONNAIRE

## APPENDIX C

### SECTION II OF 31XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Crowfoot	_____	_____	_____	_____
Drive Punch	_____	_____	_____	_____
Open End Wrench	_____	_____	_____	_____
Screwdriver Bit	_____	_____	_____	_____
Socket Head Key Set	_____	_____	_____	_____
Flexible Mechanical Finger	_____	_____	_____	_____
Screwdriver Holder	_____	_____	_____	_____
Torque Wrench Adapter	_____	_____	_____	_____
Ballpeen Hammer	_____	_____	_____	_____
Tube Bender Set	_____	_____	_____	_____
Shears	_____	_____	_____	_____
Tube Cutter	_____	_____	_____	_____
Elec. Alignment Tool	_____	_____	_____	_____
Thickness Gauge	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Straight Edge	—	—	—	—
Tube Flaring Tool	—	—	—	—
Desoldering Iron Kit	—	—	—	—
Grease Gun	—	—	—	—
Ratchet Handle	—	—	—	—
Air Chuck	—	—	—	—
Elec. Soldering Iron	—	—	—	—
Wire Stripper	—	—	—	—
Carpenter's Square	—	—	—	—
Inspection Mirror	—	—	—	—
Putty Knife	—	—	—	—
Electrician's Knife	—	—	—	—
End-Cut Nippers	—	—	—	—
Cold Chisel	—	—	—	—
Rubber Mallet	—	—	—	—
Jeweler's Screwdriver	—	—	—	—
Twist-Wire Plier	—	—	—	—
Round-Nose Plier	—	—	—	—
Retaining-Ring Plier	—	—	—	—
Diagonal Plier	—	—	—	—
Split Joint Plier	—	—	—	—
Duckbill Plier	—	—	—	—
Tool Pouch	—	—	—	—
Socket Wrench Attach.	—	—	—	—
Phillip's Screwdriver	—	—	—	—
Elec. Scissors	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Steel Rule	_____	_____	_____	_____
Universal	_____	_____	_____	_____
Tweezers	_____	_____	_____	_____
Tape Measure	_____	_____	_____	_____
Soldering Gun	_____	_____	_____	_____
Ratchet Screwdriver	_____	_____	_____	_____
Crowfoot Head	_____	_____	_____	_____
Pin Vise	_____	_____	_____	_____
Plier Clamp	_____	_____	_____	_____
Soldering Torch Kit	_____	_____	_____	_____
Flat Screwdriver	_____	_____	_____	_____
Offset Screwdriver	_____	_____	_____	_____
Scriber	_____	_____	_____	_____
Magnetic Retrieval Tool	_____	_____	_____	_____
Open-End Box Wrench	_____	_____	_____	_____
Adjustable Wrench	_____	_____	_____	_____
Extension Socket Wrench	_____	_____	_____	_____
Explosion Proof Flashlight	_____	_____	_____	_____
Ignition Wrench	_____	_____	_____	_____
Pneumatic Repair Tool	_____	_____	_____	_____
Hacksaw Frame	_____	_____	_____	_____
Tire Pressure Gauge	_____	_____	_____	_____
Goggles	_____	_____	_____	_____
Penlight Flashlight	_____	_____	_____	_____
Pin Straightener	_____	_____	_____	_____
Pinch-Off Tool	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Soldering Aid Tool	_____	_____	_____	_____
Angular Heat Sink	_____	_____	_____	_____
Cut & Flare Tube Kit	_____	_____	_____	_____
Pipe Strap-Wrench	_____	_____	_____	_____
Adjustable Pipe Wrench	_____	_____	_____	_____
Adjustable Spiral Wrench	_____	_____	_____	_____
Electric Etcher	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

_____	_____
_____	_____
_____	_____

APPENDIX D  
SECTION II OF 32XXX QUESTIONNAIRE

## APPENDIX D

### SECTION II OF 32XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Scriber	_____	_____	_____	_____
Solder Seizer	_____	_____	_____	_____
Solder Removing Tool	_____	_____	_____	_____
Hemostat Forceps	_____	_____	_____	_____
Telescoping Wrench	_____	_____	_____	_____
Hand Oiler	_____	_____	_____	_____
Duckbill Pliers	_____	_____	_____	_____
Thickness Gauge	_____	_____	_____	_____
Magnifier	_____	_____	_____	_____
Pinch Bar	_____	_____	_____	_____
Bench Block	_____	_____	_____	_____
Taper Tap	_____	_____	_____	_____
Plug Tap	_____	_____	_____	_____
Straightening Pin	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Goggles	_____	_____	_____	_____
Tape Measure	_____	_____	_____	_____
Reamer	_____	_____	_____	_____
Tap & Ream Wrench	_____	_____	_____	_____
Depth Gauge	_____	_____	_____	_____
Sharpening Stone	_____	_____	_____	_____
Jeweler's Pliers	_____	_____	_____	_____
Typewriter Wrench	_____	_____	_____	_____
Adjustable Spiral Wrench	_____	_____	_____	_____
Bar Magnet	_____	_____	_____	_____
Drill Set	_____	_____	_____	_____
Side-Handle Hand Drill	_____	_____	_____	_____
Mechanical Finger	_____	_____	_____	_____
Socket Head Key Set	_____	_____	_____	_____
Alignment Tool Kit	_____	_____	_____	_____
Contact Burnisher	_____	_____	_____	_____
Desoldering Iron Kit	_____	_____	_____	_____
Ratchet Handle	_____	_____	_____	_____
Screwdriver Bit Set	_____	_____	_____	_____
Ballpeen Hammer	_____	_____	_____	_____
Crimping Tool	_____	_____	_____	_____
Inspection Mirror	_____	_____	_____	_____
Electrician's Knife	_____	_____	_____	_____
Nippers	_____	_____	_____	_____
Double-Cut File Set	_____	_____	_____	_____
Cold Chisel	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Screwdriver Ratchet	_____	_____	_____	_____
Offset Screwdriver	_____	_____	_____	_____
Wire-Twist Pliers	_____	_____	_____	_____
Round-Nose Pliers	_____	_____	_____	_____
Diagonal Pliers	_____	_____	_____	_____
Round, Curved Pliers	_____	_____	_____	_____
Split-Joint Plier	_____	_____	_____	_____
Electric Lantern	_____	_____	_____	_____
Tool Pouch	_____	_____	_____	_____
Soldering Aid Tool	_____	_____	_____	_____
Scissors	_____	_____	_____	_____
Steel Rule	_____	_____	_____	_____
Punch	_____	_____	_____	_____
Soldering Iron	_____	_____	_____	_____
Universal	_____	_____	_____	_____
Jeweler's Screwdriver	_____	_____	_____	_____
Magnetic Retrieving Tool	_____	_____	_____	_____
Open-End Wrenches	_____	_____	_____	_____
Adjustable Wrenches	_____	_____	_____	_____
Flashlight	_____	_____	_____	_____
Penlight Flashlight	_____	_____	_____	_____
File Handle	_____	_____	_____	_____
Smooth File	_____	_____	_____	_____
Pin Vise	_____	_____	_____	_____
Wire Stripper	_____	_____	_____	_____
Pliers, Without Cutter	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Tweezers	_____	_____	_____	_____
Box Wrenches	_____	_____	_____	_____
Pocket Knife	_____	_____	_____	_____
Drive-End Handle	_____	_____	_____	_____
Counter Sink	_____	_____	_____	_____
Socket Extension	_____	_____	_____	_____
Retaining Ring Pliers	_____	_____	_____	_____
Tuning Wand	_____	_____	_____	_____
Fuse Pullers	_____	_____	_____	_____
Capacitor Tuning Tool	_____	_____	_____	_____
Dental Pliers	_____	_____	_____	_____
Machinist's Hammer	_____	_____	_____	_____
Gobbler Soldering Iron	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

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APPENDIX E  
SECTION II OF 42XXX QUESTIONNAIRE

## APPENDIX E

### SECTION II OF 42XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Air Chuck	_____	_____	_____	_____
Punch	_____	_____	_____	_____
Hand Drill	_____	_____	_____	_____
Speeder Handle	_____	_____	_____	_____
Offset Box-Wrenches	_____	_____	_____	_____
Outside Micro-Caliber	_____	_____	_____	_____
Monocular Magnifier	_____	_____	_____	_____
Ratchet Screwdriver	_____	_____	_____	_____
Offset Screwdriver	_____	_____	_____	_____
Angular Box-Wrenches	_____	_____	_____	_____
Adjustable Wrenches	_____	_____	_____	_____
Half-Moon Box-Wrenches	_____	_____	_____	_____
Paint Brushes	_____	_____	_____	_____
Socket Wrench Set	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Crimping Tool	_____	_____	_____	_____
Wire Gauge	_____	_____	_____	_____
Steel Tape Gauge	_____	_____	_____	_____
Drive-End Handle	_____	_____	_____	_____
Electric Soldering Iron	_____	_____	_____	_____
Wire Stripper	_____	_____	_____	_____
Trimming Shears	_____	_____	_____	_____
Fuse Puller	_____	_____	_____	_____
Soldering Gun	_____	_____	_____	_____
File Cleaning Brush	_____	_____	_____	_____
Screw Extractor Set	_____	_____	_____	_____
Metal Stamp Die Set	_____	_____	_____	_____
Copper Hammer	_____	_____	_____	_____
Twist-Drill Gauge	_____	_____	_____	_____
Rubber Mallet	_____	_____	_____	_____
Round-Nose, Curved Pliers	_____	_____	_____	_____
Tweezers	_____	_____	_____	_____
Tape Measure	_____	_____	_____	_____
Portable Electric Drill	_____	_____	_____	_____
Tinner's Hammer	_____	_____	_____	_____
Electric Lantern	_____	_____	_____	_____
Awl	_____	_____	_____	_____
Multimeter	_____	_____	_____	_____
Drill Set	_____	_____	_____	_____
Sharpening Stone	_____	_____	_____	_____
Goggles	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Box Wrenches	—	—	—	—
Wood Chisels	—	—	—	—
Adjustable Pipe Wrenches	—	—	—	—
Strap Pipe-Wrenches	—	—	—	—
Ballpeen Hammer	—	—	—	—
Short-Nose Pliers	—	—	—	—
Wire Stripper	—	—	—	—
Hacksaw Frame	—	—	—	—
Pocket Knife	—	—	—	—
Open-End Wrenches	—	—	—	—
Magnetic Retrieving Tool	—	—	—	—
Flat Screwdrivers	—	—	—	—
Scriber	—	—	—	—
Jeweler's Screwdriver	—	—	—	—
Universal	—	—	—	—
Tool Pouch	—	—	—	—
Punch	—	—	—	—
Duckbill Pliers	—	—	—	—
Diagonal Pliers	—	—	—	—
Retaining Ring Pliers	—	—	—	—
Taper Tap	—	—	—	—
Slip-Joint Pliers	—	—	—	—
Cold Chisel	—	—	—	—
Slide Caliper	—	—	—	—
Crow Foot	—	—	—	—
Cowl Fastener Key	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Taper File	—	—	—	—
Square Smooth File	—	—	—	—
Bit Set	—	—	—	—
Pinch Bar	—	—	—	—
Pry Bar	—	—	—	—
Brake-Shoe Adjust Tool	—	—	—	—
Pneumatic Repair Tool	—	—	—	—
Battery Terminal Pliers	—	—	—	—
Ratchet Wrench	—	—	—	—
Tube Cutter	—	—	—	—
Flaring Tool	—	—	—	—
Hand Reamer	—	—	—	—
Wire Stripper	—	—	—	—
Monkey Wrench	—	—	—	—
Pipe Wrench	—	—	—	—
Rawhide Mallet	—	—	—	—
Hinged Socket Set	—	—	—	—
Depth Gauge	—	—	—	—
Thread Restorer File	—	—	—	—
Pin Vise	—	—	—	—
Steel Rule	—	—	—	—
Tap & Ream Wrench	—	—	—	—
Twist Drill Set	—	—	—	—
Alignment Tool	—	—	—	—
Mechanical Fingers	—	—	—	—
Cutting Punch	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Inspection Mirror	_____	_____	_____	_____
Ratchet Handle	_____	_____	_____	_____
Putty Knife	_____	_____	_____	_____
Craftsman's Knife	_____	_____	_____	_____
Electrician's Knife	_____	_____	_____	_____
Wire-Twist Pliers	_____	_____	_____	_____
Plier Clamp	_____	_____	_____	_____
Electrician's Scissors	_____	_____	_____	_____
Socket Adaptor Assembly	_____	_____	_____	_____
Adjustable Spanner Wrenches	_____	_____	_____	_____
Flashlight	_____	_____	_____	_____
Penlight Flashlight	_____	_____	_____	_____
Head Socket Key Set	_____	_____	_____	_____
Socket Extension	_____	_____	_____	_____
Screwdriver Bits	_____	_____	_____	_____
Hand Drill	_____	_____	_____	_____
Flat Second Cut File	_____	_____	_____	_____
Screwdriver Holder	_____	_____	_____	_____
Half-Round File	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

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APPENDIX F  
SECTION II OF 43XXX QUESTIONNAIRE

## APPENDIX F

### SECTION II OF 43XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Brake Shoe Adjustment Tool	_____	_____	_____	_____
Plier Wrench	_____	_____	_____	_____
Drive-End Handle	_____	_____	_____	_____
Goggles	_____	_____	_____	_____
Magnetic Retrieving Tool	_____	_____	_____	_____
Spark Plug Wrench	_____	_____	_____	_____
Awl	_____	_____	_____	_____
Screw Extractor	_____	_____	_____	_____
Die Set Letters	_____	_____	_____	_____
Hand Stamping Die Set	_____	_____	_____	_____
Swaging Tool Kit	_____	_____	_____	_____
Tire Valve Repair Tool	_____	_____	_____	_____
Hacksaw Frame Handle	_____	_____	_____	_____
Telescoping Gauge	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Micro Caliper	—	—	—	—
Inside Caliper	—	—	—	—
Cowl Fastener Key	—	—	—	—
Offset Screwdriver	—	—	—	—
Monkey Wrench	—	—	—	—
Pneumatic Wrench	—	—	—	—
Screwdriver Bits	—	—	—	—
Socket Head Key Set	—	—	—	—
Socket Extension	—	—	—	—
Sidehandle Drill Handle	—	—	—	—
Half-Round Smooth File	—	—	—	—
Second-Cut File	—	—	—	—
Socket Handle	—	—	—	—
Screwdriver Holder	—	—	—	—
Crow Foot	—	—	—	—
Mechanical Finger	—	—	—	—
Ratchet Handle	—	—	—	—
Cotter-Pin Extractor	—	—	—	—
Air Chuck	—	—	—	—
Putty Knife	—	—	—	—
Craftsman Knife	—	—	—	—
Electrician's Knife	—	—	—	—
Tire Gauge	—	—	—	—
Ear Protector	—	—	—	—
10X Magnifier	—	—	—	—
Inspection Mirror	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Open End Wrench	_____	_____	_____	_____
Inflating Air Chuck	_____	_____	_____	_____
Rawhide Mallet	_____	_____	_____	_____
Cold Chisel	_____	_____	_____	_____
Thread Restoring File	_____	_____	_____	_____
Thickness Gauge	_____	_____	_____	_____
Tool Cleaning Brush	_____	_____	_____	_____
Twist Wire Pliers	_____	_____	_____	_____
Metal Shears	_____	_____	_____	_____
Hand Oiler	_____	_____	_____	_____
Round Nose Pliers	_____	_____	_____	_____
Diagonal Pliers	_____	_____	_____	_____
Slip Joint Pliers	_____	_____	_____	_____
Tap	_____	_____	_____	_____
Duckbill Pliers	_____	_____	_____	_____
Punch	_____	_____	_____	_____
Tool Pouch	_____	_____	_____	_____
Retaining Ring Pliers	_____	_____	_____	_____
Steel Rule	_____	_____	_____	_____
Universal	_____	_____	_____	_____
Tape Measure	_____	_____	_____	_____
Scriber	_____	_____	_____	_____
Box Wrenches	_____	_____	_____	_____
Angle Box Wrench	_____	_____	_____	_____
Pocket Knife	_____	_____	_____	_____
Adjustable Wrench	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Hammer	_____	_____	_____	_____
Ballpeen Hammer	_____	_____	_____	_____
Wire Brush	_____	_____	_____	_____
Strap Pipe Wrench	_____	_____	_____	_____
Adjustable Pipe Wrench	_____	_____	_____	_____
Snubber Wrench	_____	_____	_____	_____
Depth Gauge	_____	_____	_____	_____
Curved Round Pliers	_____	_____	_____	_____
Pliers Without Cutters	_____	_____	_____	_____
Crow Foot Head	_____	_____	_____	_____
Screw Starter	_____	_____	_____	_____
Tweezers	_____	_____	_____	_____
Rubber Mallet	_____	_____	_____	_____
Crow Foot Attachment	_____	_____	_____	_____
Ratchet Screwdriver	_____	_____	_____	_____
Long Nose Pliers	_____	_____	_____	_____
Diagonal Pliers	_____	_____	_____	_____
Lineman's Pliers	_____	_____	_____	_____
Magnetic Retrieving Tool	_____	_____	_____	_____
Flashlight	_____	_____	_____	_____
Monocular Magnifier	_____	_____	_____	_____
Smooth File	_____	_____	_____	_____
Rotary File	_____	_____	_____	_____
Gap Setting Gauge	_____	_____	_____	_____
Pry Bar	_____	_____	_____	_____
Dividers	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Sharpening Stone	_____	_____	_____	_____
Twist-Drill Set	_____	_____	_____	_____
Portable Pneumatic Drill	_____	_____	_____	_____
Screw Pitch Gauge	_____	_____	_____	_____
Flat Screwdriver	_____	_____	_____	_____
Hacksaw Blades	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

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APPENDIX G  
SECTION II OF 44XXX QUESTIONNAIRE

## APPENDIX G

### SECTION II OF 44XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Cotter Pin Extractor	_____	_____	_____	_____
Cold Chisel	_____	_____	_____	_____
Dikes Pliers	_____	_____	_____	_____
Flat File	_____	_____	_____	_____
Hacksaw Frame	_____	_____	_____	_____
Ballpeen Hammer	_____	_____	_____	_____
Crow Foot	_____	_____	_____	_____
Open-End Wrenches	_____	_____	_____	_____
Wrenches, Box	_____	_____	_____	_____
Socket Set	_____	_____	_____	_____
Socket Driver	_____	_____	_____	_____
Allen Wrench Set	_____	_____	_____	_____
Putty Knife	_____	_____	_____	_____
Plain Screwdriver	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Phillips Screwdriver	—	—	—	—
Universal	—	—	—	—
Breaking Bar	—	—	—	—
Speed Handle	—	—	—	—
Crescent Wrenches	—	—	—	—
Center Punch	—	—	—	—
Needle-Nose Fliers	—	—	—	—
Duckbill Pliers	—	—	—	—
Offset Screwdriver	—	—	—	—
Pipe Wrench	—	—	—	—
Water-Pump Pliers	—	—	—	—
Screwdriver Holder	—	—	—	—
Vise Grips	—	—	—	—
Apex Holder	—	—	—	—
Hand Oiler	—	—	—	—
Round File	—	—	—	—
Common Pliers	—	—	—	—
Wire Twister	—	—	—	—
Red Hammer Head	—	—	—	—
Green Hammer Head	—	—	—	—
Mechanical Finger	—	—	—	—
Hammer Head Holder	—	—	—	—
Mechanic's Pouch	—	—	—	—
Thickness Gauge	—	—	—	—
Steel Rule	—	—	—	—
Thread Restoring File	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Screw Starter	_____	_____	_____	_____
Hand Drill	_____	_____	_____	_____
Carbon Scraper	_____	_____	_____	_____
Tweezers	_____	_____	_____	_____
Magnifier	_____	_____	_____	_____
Retrieving Tool	_____	_____	_____	_____
Goggles	_____	_____	_____	_____
Fuse Pullers	_____	_____	_____	_____
Inspection Mirror	_____	_____	_____	_____
Thread Cutting Taps	_____	_____	_____	_____
Diagonal Pliers	_____	_____	_____	_____
Brace Handle	_____	_____	_____	_____
Hinge Handle	_____	_____	_____	_____
Rib-Joint Pliers	_____	_____	_____	_____
Plastic Insulated Hammer	_____	_____	_____	_____
Screw Extractor Set	_____	_____	_____	_____
Conduit Pliers	_____	_____	_____	_____
Torque Adapter	_____	_____	_____	_____
Swiss File	_____	_____	_____	_____
Pocket Knife	_____	_____	_____	_____
Ford Wrench	_____	_____	_____	_____
Ratchet Adapter	_____	_____	_____	_____
Cannon-Plug Pliers	_____	_____	_____	_____
Scriber	_____	_____	_____	_____
Twist Drill	_____	_____	_____	_____
Screw Pitch Gauge	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Tape Measure	_____	_____	_____	_____
Flashlight	_____	_____	_____	_____
File Cleaner Brush	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

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APPENDIX H  
SECTION II OF 47XXX QUESTIONNAIRE



## APPENDIX H

### SECTION II OF 47XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Soldering Gun	_____	_____	_____	_____
Goggles	_____	_____	_____	_____
Hand Oiler	_____	_____	_____	_____
Crow Foot Attachment	_____	_____	_____	_____
Mechanical Finger	_____	_____	_____	_____
Screwdriver Holder	_____	_____	_____	_____
Awl	_____	_____	_____	_____
Socket Set	_____	_____	_____	_____
Screwdriver Bit Set	_____	_____	_____	_____
Inspection Mirror	_____	_____	_____	_____
Claw Hatchet	_____	_____	_____	_____
Putty Knife	_____	_____	_____	_____
Hand File	_____	_____	_____	_____
Hammer	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Crimping Tool	_____	_____	_____	_____
Open-End Wrench, Adjustable	_____	_____	_____	_____
Brake Shoe Adjusting Tool	_____	_____	_____	_____
Metal Cutting Shears	_____	_____	_____	_____
Needle-Nose Pliers	_____	_____	_____	_____
Screwdriver, Cross T	_____	_____	_____	_____
Drive Punch	_____	_____	_____	_____
Long Nose Pliers	_____	_____	_____	_____
Prick Punch	_____	_____	_____	_____
Slip-Joint Pliers	_____	_____	_____	_____
Ratchet & Attachments	_____	_____	_____	_____
Offset Screwdriver	_____	_____	_____	_____
Open-End Box Wrench	_____	_____	_____	_____
Open-End Fixed Wrench	_____	_____	_____	_____
Box Wrench	_____	_____	_____	_____
Retrieving Tool	_____	_____	_____	_____
Hammer	_____	_____	_____	_____
Crescent Wrench	_____	_____	_____	_____
Adjustable Auto Wrench	_____	_____	_____	_____
Adjustable Pipe Wrench	_____	_____	_____	_____
Wrench Socket Set	_____	_____	_____	_____
Hacksaw Blade Handle	_____	_____	_____	_____
Pneumatic Impact Wrench	_____	_____	_____	_____
Thickness Gauge	_____	_____	_____	_____
Flashlight	_____	_____	_____	_____
Extension Sockets	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Plier Wrench	—	—	—	—
Cotter-Pin Extractor	—	—	—	—
Speed Handle	—	—	—	—
Socket-Wrench Handle	—	—	—	—
Pry Bar	—	—	—	—
Drill Set	—	—	—	—
Wrecking Bar	—	—	—	—
Slip Joint Pliers	—	—	—	—
Straight, Needle Pliers	—	—	—	—
Retaining Ring Plier	—	—	—	—
Double Cutting Punch	—	—	—	—
Universal-Joints Socket	—	—	—	—
Chain Nose Pliers	—	—	—	—
Brake Repair Pliers	—	—	—	—
Automatic Center Punch	—	—	—	—
Portable Electric Drill	—	—	—	—
Portable Tool Box	—	—	—	—
Satchel Tool Bag	—	—	—	—
Gap Setting Gauge	—	—	—	—
Machinist Steel Rule	—	—	—	—
Measuring Tape	—	—	—	—
File Cleaner Brush	—	—	—	—
Half-Round Smooth File	—	—	—	—
Rotary File	—	—	—	—
Clamp Plier	—	—	—	—
Rawhide Mallet	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Cold Chisel	_____	_____	_____	_____
Flexible Carbon Scraper	_____	_____	_____	_____
Soldering Torch Kit	_____	_____	_____	_____
Wire Stripper	_____	_____	_____	_____
Adjustable Spanner Wrench	_____	_____	_____	_____
Glass Cutter	_____	_____	_____	_____
Stencil Cutting Knife	_____	_____	_____	_____
Curved-Tooth Hand File	_____	_____	_____	_____
Parrot-Nose Pliers	_____	_____	_____	_____
Curved-Jaw Wrench-Pliers	_____	_____	_____	_____
Pocket Knife	_____	_____	_____	_____
Angular, Offset Box-Wrench	_____	_____	_____	_____
Adjustable Pipe-Wrench	_____	_____	_____	_____
Tube Flaring Tool	_____	_____	_____	_____
Sharpening Stone	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

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APPENDIX I  
SECTION II OF 53XXX QUESTIONNAIRE

## APPENDIX I

### SECTION II OF 53XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to  
manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Hand Hammer	_____	_____	_____	_____
Putty Knife	_____	_____	_____	_____
Six Blade Knife	_____	_____	_____	_____
Scraping Knife	_____	_____	_____	_____
Chalk Line & Reel	_____	_____	_____	_____
Socket Head Key Set	_____	_____	_____	_____
File Cleaning Brush	_____	_____	_____	_____
Sidehandle Drill Handle	_____	_____	_____	_____
Half Round Smooth File	_____	_____	_____	_____
Flat File	_____	_____	_____	_____
Rotary File	_____	_____	_____	_____
Socket Handle	_____	_____	_____	_____
Screwdriver Bits	_____	_____	_____	_____
Cold Chisel	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Dimpling Punch	—	—	—	—
Mechanical Finger	—	—	—	—
Steel Tape Gauge	—	—	—	—
Sheet Metal Holder	—	—	—	—
"C" Clamps	—	—	—	—
Screwdriver Holder	—	—	—	—
Dimpling Die	—	—	—	—
Rivet Cutter	—	—	—	—
Tinner's Hammer	—	—	—	—
Torque Wrench Adapter	—	—	—	—
Awl	—	—	—	—
Cotter Pin Extractor	—	—	—	—
Cutting Punch	—	—	—	—
Tube Cutter	—	—	—	—
Fastener Pliers	—	—	—	—
Taper File	—	—	—	—
Inspection Mirror	—	—	—	—
Rivet Bucking Bar	—	—	—	—
Second Cut File	—	—	—	—
Hand Rasp	—	—	—	—
Rawhide Mallet	—	—	—	—
Ratchet Handle	—	—	—	—
Drill Set	—	—	—	—
Goggles	—	—	—	—
Craftsman's Knife	—	—	—	—
Needle File	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Jeweler's Saw Frame	_____	_____	_____	_____
Slide Caliper	_____	_____	_____	_____
Depth Gauge	_____	_____	_____	_____
Copper Hammer	_____	_____	_____	_____
Counter Sinks	_____	_____	_____	_____
Ballpeen Hammer	_____	_____	_____	_____
Dividers	_____	_____	_____	_____
Spinner Socket Wrench	_____	_____	_____	_____
Punch & Die Set	_____	_____	_____	_____
Twist Drill Gauge	_____	_____	_____	_____
Nibbling Tool Sheet	_____	_____	_____	_____
End Cutting Nippers	_____	_____	_____	_____
Ratchet Screwdriver	_____	_____	_____	_____
Open End Wrenches	_____	_____	_____	_____
Offset Screwdriver	_____	_____	_____	_____
Metal Shears	_____	_____	_____	_____
Pneumatic Rivet Set	_____	_____	_____	_____
Hand Rivet Set	_____	_____	_____	_____
Plier Clamp	_____	_____	_____	_____
Round Nose Pliers	_____	_____	_____	_____
Angle Drive	_____	_____	_____	_____
Diagonal Pliers	_____	_____	_____	_____
Duckbill Pliers	_____	_____	_____	_____
Tape Measure	_____	_____	_____	_____
Slip Joint Pliers	_____	_____	_____	_____
Pocket Knife	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Taper Tap	_____	_____	_____	_____
Tool Pouch	_____	_____	_____	_____
Steel Rule	_____	_____	_____	_____
Straight Punch	_____	_____	_____	_____
Universal	_____	_____	_____	_____
Jeweler's Screwdriver	_____	_____	_____	_____
Curved Round Pliers	_____	_____	_____	_____
Pinch Off Tool	_____	_____	_____	_____
Socket Adapter Assembly	_____	_____	_____	_____
Socket Head Blade	_____	_____	_____	_____
Counter Sink Holder	_____	_____	_____	_____
Extension Chuck	_____	_____	_____	_____
Hacksaw Frame	_____	_____	_____	_____
Rivet Set	_____	_____	_____	_____
Open End Box Wrenches	_____	_____	_____	_____
Box Wrench Set	_____	_____	_____	_____
Drill Extension Rod	_____	_____	_____	_____
Explosion Proof Flashlight	_____	_____	_____	_____
Square	_____	_____	_____	_____
Portable Pneumatic Hammer	_____	_____	_____	_____
Portable Pneumatic Drill	_____	_____	_____	_____
Pulling Head	_____	_____	_____	_____
Angle Attachment	_____	_____	_____	_____
Blind Hand Riveter	_____	_____	_____	_____
Adjustable Wrenches	_____	_____	_____	_____
Pinking Shears	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Paint Spray Gun	_____	_____	_____	_____
Ratchet Wrench	_____	_____	_____	_____
Drafting Compass	_____	_____	_____	_____
Tap & Ream Wrench	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

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APPENDIX J  
SECTION II OF 54XXX QUESTIONNAIRE

## APPENDIX J

### SECTION II OF 54XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Alignment Tool	_____	_____	_____	_____
Tube Flaring Tool	_____	_____	_____	_____
Outside Caliper	_____	_____	_____	_____
Fastener Pliers	_____	_____	_____	_____
Taper File	_____	_____	_____	_____
Rawhide Mallet	_____	_____	_____	_____
Inspection Mirror	_____	_____	_____	_____
Socket Handle	_____	_____	_____	_____
Ratchet Handle	_____	_____	_____	_____
Gap Setting Gauge	_____	_____	_____	_____
Hand Hammer	_____	_____	_____	_____
End Cut Nippers	_____	_____	_____	_____
Hand Oiler	_____	_____	_____	_____
Rubber Mallet	_____	_____	_____	_____



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Wire Stripper	—	—	—	—
Slip Joint Pliers	—	—	—	—
Punch	—	—	—	—
Round Nose Pliers	—	—	—	—
Long Nose Pliers	—	—	—	—
Socket Wrench	—	—	—	—
Swaging Tool Kit	—	—	—	—
Socket Adapter	—	—	—	—
Mechanical Puller	—	—	—	—
Pinch Off Tool	—	—	—	—
Universal	—	—	—	—
Jeweler's Screwdriver	—	—	—	—
Goggles	—	—	—	—
Hand Reamer	—	—	—	—
Magnetic Retrieving Tool	—	—	—	—
Angle Box Wrenches	—	—	—	—
Open End Box Wrenches	—	—	—	—
Hacksaw Frame	—	—	—	—
Adjustable Wrenches	—	—	—	—
Pipe Cutter	—	—	—	—
Tweezers	—	—	—	—
Dividers	—	—	—	—
Wire Brush	—	—	—	—
Strap Pipe Wrench	—	—	—	—
Thickness Gauge	—	—	—	—
Metal Shears	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Elec Soldering Iron	—	—	—	—
Scrapper	—	—	—	—
Fuse Puller	—	—	—	—
Wire Gauge	—	—	—	—
Awl	—	—	—	—
Level & Plumb	—	—	—	—
Masonry Star Drill	—	—	—	—
Alignment Tool Kit	—	—	—	—
Auger Bits	—	—	—	—
Line Level	—	—	—	—
Burnisher	—	—	—	—
Desoldering Iron Kit	—	—	—	—
Screw Extractor	—	—	—	—
Center Gauge	—	—	—	—
Slide Caliper	—	—	—	—
Electronic Indicator	—	—	—	—
"C" Clamp	—	—	—	—
Cable Stripper	—	—	—	—
Nested Saw Blades	—	—	—	—
Folding Rule	—	—	—	—
Soldering Aid Tool	—	—	—	—
Staple Tacker	—	—	—	—
Reamer	—	—	—	—
Needle Nose File	—	—	—	—
Head Socket Key Set	—	—	—	—
Tube Bender Set	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
File Cleaner Brush	—	—	—	—
Cold Chisel	—	—	—	—
Smooth, Flat File	—	—	—	—
Mechanical Finger	—	—	—	—
Steel Tape Gauge	—	—	—	—
Drive-End Handle	—	—	—	—
Ballpeen Hammer	—	—	—	—
Tube Cutter	—	—	—	—
Screwdriver Bit	—	—	—	—
Keyhole Saw	—	—	—	—
Portable Tool Box	—	—	—	—
Electrician's Belt	—	—	—	—
Sharpening Stone	—	—	—	—
Portable Electric Drill	—	—	—	—
Thread Cutting Tap	—	—	—	—
Vise-Grip Pliers	—	—	—	—
Battery Terminal Pliers	—	—	—	—
Spark-Plug Wrench	—	—	—	—
Thread Restorer File	—	—	—	—
Gooseneck Flashlight	—	—	—	—
Multimeter	—	—	—	—
Telescope Gauge	—	—	—	—
Pinch Bar	—	—	—	—
Pry Bar	—	—	—	—
Parallel Tool Clamp	—	—	—	—
Metal Stamp Die Set	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Screw Pitch Gauge	—	—	—	—
Copper Hammer	—	—	—	—
Sledge Hammer	—	—	—	—
Retaining-Ring Pliers	—	—	—	—
Jeweler's Pliers	—	—	—	—
Micro-Caliper	—	—	—	—
Ratchet Bit Brace	—	—	—	—
Soldering Torch Kit	—	—	—	—
Manifold Gauge Assembly	—	—	—	—
Leak Detector	—	—	—	—
Upset-Jaw Plier Clamp	—	—	—	—
Phillips Screwdriver	—	—	—	—
Monkey Wrench	—	—	—	—
Portable Tool Box	—	—	—	—
Pocket Level	—	—	—	—
Line Volt Indicator	—	—	—	—
Scriber	—	—	—	—
Cut-Flare Kit	—	—	—	—
Cotter-Pin Extractor	—	—	—	—
Putty Knife	—	—	—	—
Electrician's Knife	—	—	—	—
Adjustable Pipe-Wrench	—	—	—	—
Acid Swabbing Brush	—	—	—	—
Pipe-Wrench	—	—	—	—
Leather Tool Carrier	—	—	—	—
Flashlight	—	—	—	—



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Penlight Flashlight	_____	_____	_____	_____
Satchel Tool Bag	_____	_____	_____	_____
Flaring Tool	_____	_____	_____	_____
Drill Set	_____	_____	_____	_____
Leak Detector Kit	_____	_____	_____	_____

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

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APPENDIX K  
SECTION II OF 55XXX QUESTIONNAIRE

## APPENDIX K

### SECTION II OF 55XXX QUESTIONNAIRE

Place an "X" in the column that describes your evaluation of each tool.

Use the definitions listed below in your evaluation.

SUPERIOR - The tool is versatile, efficient, or preferred.

ADEQUATE - The tool is effective, worthwhile, or useful.

INADEQUATE - The tool is inappropriate, awkward, or hard to  
manipulate.

NOT ISSUED - The tool was not issued to me or I can't identify it.

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Electrician's Knife	_____	_____	_____	_____
Dividers	_____	_____	_____	_____
Counter Sinks	_____	_____	_____	_____
Wire Stripper	_____	_____	_____	_____
Flat Screwdriver	_____	_____	_____	_____
Split-Joint Pliers	_____	_____	_____	_____
Chalk Line & Reel	_____	_____	_____	_____
End-Cut Nippers	_____	_____	_____	_____
Hand File	_____	_____	_____	_____
Dusting Brush	_____	_____	_____	_____
Plier Clamp	_____	_____	_____	_____
Sharpening Stone	_____	_____	_____	_____
Metal Shears	_____	_____	_____	_____
Diagonal Pliers	_____	_____	_____	_____

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Wooden Rule	—	—	—	—
Duckbill Pliers	—	—	—	—
Basin Wrench	—	—	—	—
Trowel	—	—	—	—
Gum Caulk	—	—	—	—
Ratchet Screwdriver	—	—	—	—
Vise-Grip Pliers	—	—	—	—
Needle-Nose Pliers	—	—	—	—
Spinner Socket Wrench	—	—	—	—
Curved-Jaw Pliers	—	—	—	—
Parrot-Nose Pliers	—	—	—	—
Clutch Tip Screwdriver	—	—	—	—
Staple Hammer	—	—	—	—
Compound Pliers	—	—	—	—
Caulking Gun	—	—	—	—
Fuse Puller Pliers	—	—	—	—
Tape Measure	—	—	—	—
Open-End Box-Wrenches	—	—	—	—
Adjustable Wronches	—	—	—	—
Key Hole Saw	—	—	—	—
Pipe Cutter	—	—	—	—
Cross-Cut Hand-Saw	—	—	—	—
Monkey Wrench	—	—	—	—
Hammer	—	—	—	—
Woodworking Chisels	—	—	—	—
Hand Drill	—	—	—	—

<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Screwdriver Bit Set	—	—	—	—
File Cleaner Brush	—	—	—	—
Glass Cutter	—	—	—	—
Awl	—	—	—	—
Level & Plumb	—	—	—	—
Sliding Bevel	—	—	—	—
Auger Bits	—	—	—	—
Line Level	—	—	—	—
Hand Rasp	—	—	—	—
Socket Head Key Set	—	—	—	—
Half-Round File	—	—	—	—
Mechanical Finger	—	—	—	—
Ballpeen Hammer	—	—	—	—
Tube Flaring Tool	—	—	—	—
Tube Cutter	—	—	—	—
Line Volt Indicator	—	—	—	—
Pry Bar	—	—	—	—
Round, Smooth File	—	—	—	—
Hawkbill Knife	—	—	—	—
Hand Caulking Tool	—	—	—	—
Goggles	—	—	—	—
Knee-pads	—	—	—	—
Magnetized Tack Hammer	—	—	—	—
Solder Torch Kit	—	—	—	—
Hand Oiler	—	—	—	—
Scriber	—	—	—	—



<u>NAME OF TOOL</u>	<u>SUPERIOR</u>	<u>ADEQUATE</u>	<u>INADEQUATE</u>	<u>NOT ISSUED</u>
Masonry Drill	—	—	—	—
Drill Set Kit	—	—	—	—
Claw Hammer	—	—	—	—
Wrecking Bar	—	—	—	—
Pocket Knife	—	—	—	—
Nail Sets	—	—	—	—
Taper File	—	—	—	—
Putty Knife	—	—	—	—
Block Plane	—	—	—	—
Pipe Wrench Set	—	—	—	—
Strap Pipe-Wrench	—	—	—	—
Flashlight	—	—	—	—
Portable Electric Drill	—	—	—	—
Drill Set	—	—	—	—
Angular, Offset Box-Wrench	—	—	—	—
Carpenter's Tool Chest	—	—	—	—
Staple Tacker	—	—	—	—
Jack Plane	—	—	—	—
Ratchet Bit Brace	—	—	—	—

List below any additional tools, equipment, or protective clothing you consider to be INADEQUATE that were issued to you and did not appear in the above list and indicate in the next section why you feel they are INADEQUATE.

_____	_____
_____	_____
_____	_____

APPENDIX L  
AGE DISTRIBUTIONS (IN YEARS)

## APPENDIX L

### AGE DISTRIBUTIONS (IN YEARS)

Perce- tile	All Enlisted WAF in Medical and Administrative Skills	All Enlisted WAF in Craft Skills	All 3 & 5-Level Enlisted WAF in Craft Skills
99th	40.4	28.50	28.67
95th	25.6	26.58	26.33
90th	23.4	25.25	24.92
80th	21.8	23.33	23.33
70th	21.0	22.25	22.25
60th	20.4	21.33	21.33
50th	19.9	20.67	20.75
40th	19.6	20.25	20.33
30th	19.2	19.83	20.08
20th	18.8	19.50	19.75
10th	18.4	19.17	19.50
5th	18.2	18.92	19.33
1st	18.0	18.33	19.17
Average	20.87	21.48	21.60

APPENDIX M  
HEIGHT DISTRIBUTIONS (IN INCHES)

# APPENDIX M

## HEIGHT DISTRIBUTIONS (IN INCHES)

Percentile	Medical and Administrative WAF	Craft Skill WAF Respondents
99th	69.48	71
95th	67.77	69
90th	66.89	68
80th	65.82	67
70th	65.05	66
60th	64.39	66
50th	63.77	65
40th	63.15	64
30th	62.49	63
20th	61.74	63
10th	60.74	61
5th	59.55	60
1st	58.87	59
Average	63.82	64.86



APPENDIX N  
WEIGHT DISTRIBUTIONS (IN POUNDS)

## APPENDIX N

### WEIGHT DISTRIBUTIONS (IN POUNDS)

Percentile	Medical and Administrative WAF	Craft Skill WAF Respondents
99th	175.20	155
95th	156.38	145
90th	148.49	145
80th	140.15	140
70th	134.63	135
60th	130.15	130
50th	126.08	130
40th	122.08	125
30th	117.89	120
20th	113.10	115
10th	106.86	110
5th	102.29	105
1st	96.36	95
Average	127.28	126.82

APPENDIX O  
HAND LENGTH DISTRIBUTIONS (IN INCHES)

## APPENDIX O

### HAND LENGTH DISTRIBUTIONS (IN INCHES)

Percentile	Medical and Administrative WAF	Craft Skill WAF Respondents
99th	8.17	8.00
95th	7.89	7.70
90th	7.74	7.55
80th	7.55	7.30
70th	7.42	7.15
60th	7.31	7.05
50th	7.22	6.95
40th	7.12	6.80
30th	7.02	6.70
20th	6.91	6.55
10th	6.77	6.35
5th	6.65	6.20
1st	6.44	5.95
Average	7.24	6.93

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